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CONTENTS.

ARTICLES. PAGE

1. Criminal Law of the Future 591
2. American Nervousness. By GEORGE M. BEARD, M.D. .. 598
3. Moving Rocks 610
4. Petroleum as a Steam-maker 612
5. The May Tornadoes of Kansas and Missouri 613
6. The Pirate's Sheet-Anchor .. 622
7. British Association Meeting 629

NOTICES OF BOOKS.

Fragments of Science 642
Researches on the Motion of the Moon 642
A Treatise in Popular Language on the Solar Illumination of the Solar System 643

PAGE

NOTICES OF BOOKS—*continued.*

Dreams of my Solitude on the Mysteries of the Heavens .. 643
Navigation and Nautical Astronomy, with Special Table, Diagram, and Rules adapted for Navigating Iron Ships .. 644
The Electric Light in its Practical Applications 644
The Student's Text-Book of Electricity 646
Four Lectures on Static Electric Induction 646
Mechanics 646
&c., &c.

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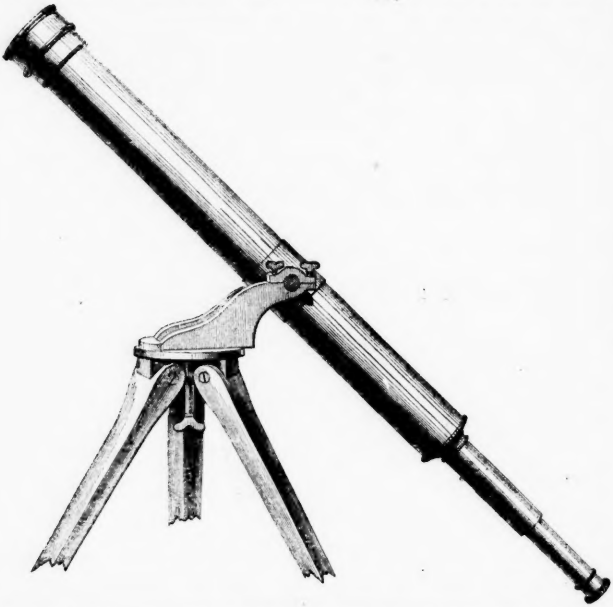

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XUM

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THE MONTHLY

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I. THE CRIMINAL LAW OF THE FUTURE.

NOTHING is more common than for men to express an authoritative opinion upon subjects which lie remote from their ordinary sphere, and which they have never made the theme of serious study. Very frequently it happens that their lucubrations are received with more favour than are the writings of the specialist based upon the researches of a lifetime. We see for instances novelists, barristers, dramatists, statesmen, and the like, who have never worked for a single hour in a biological laboratory, come forward with the most charming confidence to solve such problems as the origin of organic species.

Hence surely it will not be deemed unpardonable presumption if a biologist, in his turn, attempts to apply one of the most recent principles of his science to an important social question—we mean to the treatment of crime.

It is well known that the general current of what is called the "spirit of the age" has tended in the direction of increasing leniency to offenders. Capital punishments have been abolished in some countries with but very unsatisfactory results, as may be seen in Italy, Switzerland, and Spain. In others they are greatly restricted, even in case of the most monstrous crimes. "Extenuating circumstances" in France and recommendations to mercy in England save many a villain from the gallows. Not content with this state of things, we have a "movement" and a society for the total abolition of the extreme penalty. What the next step will be if this is effected we know not, unless garotters, corner men, and ruffians in general are to receive a bonus for every unoffending person they maim or kill. It may

XUM

perhaps surprise those who are so anxious for the path of crime to be strewn with roses, if they are told that the legitimate conclusions to be drawn from one of the most interesting laws of organic science point in an exactly opposite direction. How this can be the case will at once appear if we refer to one of the stock-arguments of the opponents of capital punishment. They sometimes remind us that if a locomotive explodes, occasioning damage and perhaps loss of life, we do not break it up for old metal, but send it to be repaired. It might, however, strike them that between the defective locomotive and the criminal, especially the murderer, there are points of distinction which make their parable worthless. Let us suppose these differences done away with. Suppose good locomotives were so plentiful that employment for many of them could not be found. Suppose bad locomotives could not be reduced to inactivity and consequent harmlessness at our will, but were all to go on of their own accord, working and doing damage. Suppose, further, that if sent for repairs to a competent engineer we had still no positive means of knowing whether they were rendered trustworthy, or whether their defects were merely hidden for a time, to re-appear on some future occasion. Lastly, let us suppose that these unsafe locomotives had the power of reproduction, giving rise to others no less dangerous than themselves. Were such the case common prudence—the instinct of self-preservation—would at once bid us to destroy such formidable machinery before it had opportunity to work further mischief.

This brings us at once to the point—the question of heredity. Are children not absolutely certain, but at least very likely, to resemble their parents, grand-parents, and more remote ancestors, not merely in complexion, figure, or stature, but in habits, in intelligence, in disposition, in force of will, and in all that is generally summed up under the word character? The doctrine is unpopular, since it has the misfortune to come into collision not with facts, not with established truths, but—what is perhaps worse—with dogmas. Two most antagonistic schools of thought fear that should the principle of heredity be formally recognised their systems will stand in need of revision. On the one hand, we encounter the radical or revolutionary sect of world-betterers, political and social, who not unnaturally see that if heredity is a fact, human equality—a main point of their creed—must be greatly limited, and that aristocracies have an existence founded in the nature of man. On the other hand, many theological and ethical authorities of

great ability and weight consider heredity scarcely compatible with the doctrine of personal responsibility. If a man is born a murderer, how, they ask, can he be justly punished for murder?

We will first address ourselves to this latter class of objectors, as being apparently the more sincere and the more candid. They seem to consider that morally, if not intellectually and physically, every man is born alike. They do not, of course, deny the glaring, palpable fact that crime has run in certain families, but they contend that this result is due not to any transmitted innate peculiarities, but rather to evil example and bad training. These views are forcibly expressed by Dr. J. Mortimer Granville, in a paper on the "Physical Theory of Sin," recently published in "Good Words." None of the advocates of heredity, of course, are likely to deny that example and training in early life and companionship in later years are real and potent factors in the formation of character. Nor can it be questioned that the children of professional criminals are placed under very unfavourable circumstances. If not systematically misled, they are left to their own guidance, and to the contaminating influences around them. Still these post-natal circumstances are, we hold, far from explaining the whole of the case. Instances may be found where children of a criminal strain have been withdrawn from their parents at too early an age to have been corrupted either by bad precept or worse example, have been placed in virtuous society, and surrounded by the best moral influences; yet as they reached maturity their inborn criminal tendencies were manifested on the earliest opportunity. The writer may here be permitted to bring forward a case which happened within the scope of his personal observation, and for which he is prepared to vouch:—G. J. C., a young man of good family, was not certainly a criminal, but was what is known in America as a *loafer*. He was thoroughly idle, shiftless, intemperate, and profligate when he had money at command, and at other times ready to sponge upon his friends. Unfortunately he prevailed upon a young lady, ignorant of his character and position, to become his wife. After a short and unhappy married life he left her, went to Canada, and died there. The lady thus forsaken brought up her two sons—the elder of whom was not three years and the younger about ten months of age at the time of their father's departure—most carefully. That his example or conversation could have had any effect upon them is impossible. All influences for good which could be brought

to bear upon them, at home, at school, and at church, were perseveringly applied. The younger, however, grew up to be the image of his father, in character as in person. If the doubters of heredity would watch with sufficient care, they could not fail to detect the transmission from father to son of traits of character, whims, and caprices incapable of being taught, and little likely to be adopted from imitation. And if dispositions are thus inherited in their minutest peculiarities, are the bolder and more decided features likely to escape reproduction? But why should theologians and moralists fear that if we admit the inheritance of character it will no longer be possible to maintain responsibility? As regards human laws this is altogether a delusion. Suppose a murderer pleads, as an apology for or extenuation of his deed, that he is sprung from a criminal stock, and cannot help taking life. Even admitting this helplessness—which after all by no means follows—Society may reply that this proves only the more convincingly the necessity for his elimination.

Nor can heredity be pronounced incompatible with man's responsibility before God. Does it not, after all, include the theological dogma of Original Sin, which divines have always been able to reconcile with responsibility? Nay, is not the inheritance of evil tendencies formally recognised in the words "visiting the sins of the fathers upon the children unto the third and fourth generation"?

Turn we now to the revolutionary opponents of Heredity, the followers of Helvetius, who consider that if a man is only caught young, duly Board-schooled, and afterwards examined by the Art and Science Department, he can be converted into a genius, an "advanced" thinker, or a cosmopolitan philanthropist, quite as easily as china clay and sizing can be transformed into good cotton cloth. Concerning responsibility to God or to man the writers of this school are not anxious. Nor, if we mistake them not, do they confine their denial of heredity to the moral aspect of man's nature. Of their manner of argument the following may serve as a typical specimen:—"Of all vulgar modes of escaping from the consideration of the effect of social and moral influences on the human mind, the most vulgar is that of attributing the diversities of character and conduct to inherent natural differences."*

Such outbursts are of course vastly easier than the calm and exhaustive collection and appreciation of facts bearing

* JOHN STUART MILL. Political Economy, vol. i., p. 390.

on the question of heredity. But letting this pass, we may ask if external influences, moral or social, can modify the conduct and character of the individual, what is our right to assume—as the author just quoted evidently does—that their effects must cease with his death, and fail to reach his posterity? Everyone has seen a series of parallel portraits entitled "The Child; what will he become?" Can we suppose that the diverse agencies which have moulded the one into intelligence, refinement, and integrity, but have warped the other into ignorance, vice, and brutality, will leave their descendants equal and similar, the minds of both groups being *tabulæ rasæ* as easily open to good as to bad impressions? Unless we can grant this monstrous postulate we must, "vulgar" as it may seem, recognise heredity as an important factor in the generation of conduct and character.

In meeting the deniers of heredity we are, however, placed at a disadvantage, inasmuch as they have hitherto brought forward no definite and tangible arguments for its rejection, but have contented themselves with the easier task of vituperation, or of mourning over the possible consequences of its general recognition. Till they produce objections of a different stamp they may perhaps be safely ignored. One thing at least is certain, that if there be any truth in heredity it is a principle which cannot be rationally or safely ignored in the framing and enforcement of criminal law. Without at all denying that a normal man may, under circumstances of temptation, transgress against the property and even the persons of his neighbours, we must admit that on the theory of inheritance the criminal class must produce its like. The murderers, the burglars, the ruffians of our day, are the sons of similar characters who infested the country some thirty or forty years ago, and are in turn becoming the fathers of a new generation of evil-doers. Surely, then, a most important point in criminal jurisprudence is the arrest of this succession. Of what use is the occasional imprisonment and the ultimate execution of the habitual criminal if he is suffered to become a father? It is often said by the humanitarian school that in the treatment of crime we have tried severity and failed. To this argument our reply is easy:—Our severity, though in some cases excessive, was illogical, as bearing no proportion to the moral delinquency of the offender. It treated crimes against property more rigorously than those against the person, and hence it failed to eliminate the most dangerous class of offenders, and it totally overlooked the propagation

of a criminal type of population. It delivered over to the hangman a poor woman whose husband had been carried off by a pressgang, and who had stolen a loaf to feed her famishing children; but it left the sons of the highwayman and the burglar free from all *surveillance*, and could see in them nothing different from its most orderly and virtuous citizens.

Fortunately a great European nation has shown us how, by a consistent course of severity, steadily carried out, any given class of a community may be stamped out. No one can fail to be struck with the utter lack of mental eminence among the Spanish people during the present century. Neither in the practical nor in the theoretical sphere have they reached anything beyond mediocrity. If we turn to the history of discovery and invention, the development of the sciences, and their applications in industry, Spain finds there no place. She is eclipsed even by Denmark and Switzerland, whose joint populations do not reach the fourth of hers, but who out of such small numbers have produced men with whom she has nothing to compare. It is the same in speculative philosophy and imaginative literature, the same in statesmanship and in war. The reason of this is not far to seek. It cannot be traced to any original want of vigour and energy in the national character. There was a time when no people on earth could surpass the Spaniards in these attributes. Nor is it, as some foolishly urge, to be traced to the enervating influence of the treasures obtained from Mexico and Peru. Britain, America, and Russia, we see, have not been enfeebled in energy and intelligence in consequence of the gold discovered in Australia, California, or the Ural. The true cause is this—that for more than two successive centuries the Spanish nation was subjected to a most careful and systematic process of "selection"—we can scarcely call it "natural"—by the Holy Inquisition. Every man who towered above his fellows, either by force of character, mental grasp, or by an enquiring disposition, became an object of dislike, and sooner or later was disposed of by death, by incarceration, or by banishment. The search after anything new was substantially interdicted. Those only were safe who, beyond satisfying the animal wants of their system, went duly to mass and to the bull-fight, and in all things else took the world easily. The consequence has been the condition of Spain such as we now perceive. This consideration is exceedingly significant. It is a most powerful evidence of the heredity of talent and of force of character. It may well be concluded, hence,

that if, by a systematic and persevering course of action, ability, with its culminating point genius, has been stamped out among one great nation, so, by another course of action equally systematic and equally persevering, roughdom, with its culminating point crime, might be eliminated quite as thoroughly in another. It must not be forgotten that when in the good old times the Holy Office had roasted any man in the market-place, *ad majorem Dei gloriam*, it failed not to keep an especially minute watch upon the doings of his family, whether in the ascending, descending, or collateral lines. Here then it appears was a tacit admission of the heredity of character.

A still more striking recognition of the same principle is to be found in the annals of Oriental despotism. It was nothing unusual for sultan, shah, caliph, or mogul, when condemning to death any man who from points of view then prevailing was deemed an arch-criminal, to include in the sentence all his kindred. That here the mark was grossly overleapt needs little showing. All the children and other relatives, even of a Peace, are no more necessarily criminals than are all the descendants of a blood horse necessarily fit to be entered for the Derby or the St. Leger. But what the criminal legislation of the future will do—unless it be dominated by those who pander to crime—is probably this: the lineage and connections of every offender, and especially of every habitual criminal, will be carefully scrutinised, and all surviving members will be subjected to an unobtrusive but penetrating scrutiny. The younger members of the race will be as far as possible surrounded with such moral and religious influences as may most effectually check and counteract their probable inbred tendency to crime. They will be treated, *mutatis mutandis*, on the same principle as we now observe in handling petroleum spirit, nitro-glycerin, and other specially dangerous substances. Just as we guard the latter from the approach of fire, and prevent them from being accumulated in too great quantities at one place, so will the scions of a criminal family be kept from the contact of incitements to evil. Our courts of justice will have their criminal genealogists, whose records will shed a new and most valuable light on not a few unsolved problems, both of biology and of mental science.

As for the man who has once formally declared war against Society, hoisting, so to speak, the black flag, care will be taken that he shall neither repeat his offence nor after its commission become a parent.

One of the peculiarities of the half-educated public is that

its attention is always rivetted on what happened last. To it the last antecedent seems the cause of any event; the arguments of the last speaker or author on any question appear the most convincing. In like manner it pities the just sufferings of the "poor" criminal, and totally forgets his victim. We are sometimes told that a very "humane jurist" expressed the opinion that the worst possible use to which a man could be put was to hang him. We demur to this view altogether. The worst use to which a criminal can be put is to let him loose upon Society, and they who urge such spurious mildness are in truth monsters of cruelty.

II. AMERICAN NERVOUSNESS: ITS PHILOSOPHY AND TREATMENT.*

By GEORGE M. BEARD, M.D., New York.

AMERICAN nervousness, during the past half century, has expressed itself by a large variety of symptoms, a number of which are so frequent, so positive in their character, and so important that they have given names to disease, and are known as such. Among these symptoms and expressions of modern nervousness are neuralgia, sick headache, nervous dyspepsia, hay fever, and, above all, *neurasthenia*, or nervous exhaustion in all its various forms. These conditions, with others that might be mentioned, constitute a family of nervous diseases that have developed chiefly during the last half century,—at least, during the present nineteenth century,—and are most abundant, and most severe and most varied in their manifestations, in the northern portion of the United States, although they are found in, and are now extending to, England and the Continent of Europe.

The rise of this family of functional nervous diseases brings a new era into medicine and sociology, for it has no

* Abstract of an Address delivered before the Baltimore Medical and Surgical Society.

precedent in the history of mankind. The ancients had no nervous disease, or almost none, save a few cases of insanity and epilepsy here and there; and our moderns knew little or nothing about them until the present century.

The scientific proofs of this unprecedented nervousness of the Americans during this generation are very numerous.

First of all, there is the *increased sensitiveness to cold and heat* which is observed among all our brain-working classes. Our fathers were content with a temperature of 60° F. We must have, to be comfortable, a temperature of at least 70°; and there are many families who keep their rooms at even a much higher temperature. In other words, we are 10 degrees more sensitive to cold than were our fathers. The heat of our summers is no greater than it was a century ago, but the cases of sunstroke and heat prostration are widely out of proportion to the increase in our population.

One of the very best signs of our civilisation is found in the *premature decay of our teeth.* Special explanations without number have been offered for this long-observed phenomenon—such as the use of sweets, the use of acids, neglect of cleanliness, and the use of food that requires little mastication. But they who urge these special facts to account for the decay of teeth of our civilisation would, by proper inquiry, learn that the savages and negroes, and semi-barbarians everywhere, in many cases use sweets far more than we, and never clean their mouths, and never suffer, except in old age, from cavities in the teeth. The cause of the decay of teeth is subjective far more than objective, in the constitution of the modern civilised man. Similarly, also, with regard to irregularities of the teeth, which, as is now known, are dependent on bad nutrition of the jaws.

Delicacy of digestion is one of the best known and first observed effects of civilisation upon the nervous system. In all the great cities of the East, among the brain-working classes of our large cities everywhere, pork in all its varieties and preparations has taken a subordinate place among the meats upon our tables, for the reason that the stomach of the brain-worker cannot digest it. Three times a day, and every day in the year almost, pork in some form was the only dependence of our fathers in the last generation, who could eat it freely without ever asking themselves whether it was easy or hard to be digested.

The *eyes*, also, are good barometers of our nervous civilisation. The increase of æsthenopia and shortsightedness, and, in general, of the functional disorders of the eye, are demonstrated facts, and are most instructive. The great

skill and great number of our oculists are constant proof and suggestions of the nervousness of our age.

It is demonstrable that nervous diseases have increased in recent periods; and that, with this increase of nervous symptoms, there has been also an increase in the æsthenic forms of disease, and a decrease in the sthenic forms; and, correspondingly, that there has been a change in the methods of treatment of diseases; that neurasthenia—nervous susceptibility—has affected all or nearly all diseases, so that nearly all illnesses occurring among the better class of people—the brain-workers—require a different kind of treatment from that which our fathers employed for the same diseases.

The four ways by which we determine these facts are—*first*, by studying the literature of medicine of the past centuries; *secondly*, by conversation with very old and experienced practitioners—men between the ages of seventy and ninety—who link the past with the present generation, and remember their own personal experience and the practice of medicine as it was fifty years ago; *thirdly*, from our own individual experience and observation; *fourthly*, by studying the habits and diseases of savages and barbarians of all climes and ages, and of the lower orders about us.

Statistics on this subject are of very little value, for reasons that will be clear to those who are used to statistics, and who know how they can be handled. Longevity has increased almost *pari passu* with this increase of nervousness and change in type of disease, and this has been a stone of stumbling and rock of offence to those who have discussed this subject. Both facts are true; longevity has increased among the brain-working classes, and nervousness has also increased. These two apparently opposite facts are harmonised by a third factor which those who have studied this subject have failed to reach—namely, nervousness is not only consistent with longevity, but actually favours it, by preserving the system from attacks of acute inflammatory disease. We do not bear blood-letting now as our fathers did, for the same reasons that we do not bear alcohol, tobacco, coffee, opium, and physical pain as they could. The change in the treatment of disease is a necessary result of the change in the modern constitution. The old-fashioned constitution yet survives in numbers of people, and in such cases the old treatment is oftentimes better than the modern treatment.

In the study of this subject I have compared a very large number of books of travel, and I have arrived at this fact,

in regard to which there can be no doubt whatever, namely, that nervous disease scarcely exists among savages or barbarians, or semi-barbarians, or partially civilised people. Likewise, in the lower orders in our great cities, and among the peasantry in the rural districts, muscle-workers, as distinguished from brain-workers,—those who represent the habits and mode of life and diseases of our ancestors of the last century,—nervous diseases, except those of an inflammatory or syphilitic character, are about as rare as they were among all classes during the last century. These people frequently need more violent and severe purging, more blood-letting, more frequent blistering than the higher orders would endure.

What, now, are the causes of this increase of nervousness in America during the past half century? The primary cause is unquestionably civilisation, especially with its recent accompaniments, as the telegraph, railway, and the periodical press. These three institutions have drawn, and continue to draw each year, most severely on the nerves of nearly all classes, but particularly upon those who are favoured with education. The introduction and popularisation of the railway and the telegraph, and the development of the periodical press, belong, it will be observed, to the nineteenth century, and they have intensified in ten thousand ways cerebral activity and worry. This factor of civilisation applies to all the great countries—Europe as well as America.

But after we have given this cause every credit to which it is entitled, we are yet face to face with this question—Why are the Americans more nervous than any other people on this planet? The answer to this question, which has occupied the thoughts of philosophical observers for the past quarter of a century, is to be found mainly in these factors:—first, the dryness of our atmosphere; and secondly, the extremes of heat and cold. In these two respects America differs from any other civilised country.

Dryness of atmosphere produces nervousness in two ways: first, by taking up and absorbing the moisture of the body, thus causing us to literally dry up. When the atmosphere is moist, perspiration accumulates upon the surface of the body, because the air cannot take it up. Hence, in our dull dog-days, we are frequently annoyed by excessive perspiration. In a dry air which is hungry for moisture, the fluids of the body, as they become vapourised, are rapidly conducted away; the body is thus wasted of its fluids. Dry air also prevents the electricity of the body

from being conducted away, and thus we become excessively charged with that force, and excessively stimulated by its confinement in the body. Moisture conducts electricity; and the moistened air insensibly carries away the electricity of the body, so that it is impossible for the body to become so excessively charged and stimulated. The evidences of this dryness of our atmosphere are numerous and striking. Clothes on the line dry more rapidly than in Europe. The specimens of the naturalists do not so quickly mould; the hair is stiffer and drier than that of our European contemporaries, and requires more pomade and oil. This peculiarity of our climate is observed from the Atlantic to California; and the Rocky Mountain region is far more under the influence of this dryness of atmosphere than even the East. The violent extremes of heat and cold—the bitterness of our winters contrasted with the heat of our summers—excite nervousness by over-stimulation. The application of latent heat and cold, as ice in hot water, is one of the most powerful means of local stimulation that we have in medicine: to this treatment nearly all of the American people in the northern and eastern sections are constantly subjected. Secondly, extreme heat and cold produce nervousness by compelling us to live in-doors in unnaturally dry and overheated atmospheres, and making it impossible, either in summer or winter, to partake of those active out-door exercises and amusements in which our English friends indulge at nearly all seasons of the year. The English climate, as contrasted with the American, is more equable. Its moisture, and even its unpleasantness and disadvantageousness, is favourable to the nervous system; likewise, the climate of our Southern States is more moist and more uniform than of the North and West; and, according to investigations that are variously made, nervous diseases of all kinds, or nearly all kinds, pretty steadily diminish in frequency as we go South.

The institutions of civilisation common to all enlightened countries—such as schools, newspapers, excitement of elections, reforms, and revivals—are themselves the results of climate and race, and are also to be included among causes of nervousness. Civilisation is burdened with information that it must acquire; every year history raises up new facts that the schoolboy of the future must commit and recite. If we would know why the Americans are so nervous, we should contrast the Greek boy with the New York boy in their manner of training in the schools, in their play, and in the whole order of their lives. The Greek boy's life was a

poem, a constant holiday, a perpetual picnic. Of study, toil, or work, to which the New York boy is early trained, he knew nothing. Work is really a modern institution. All culture, history, science, literature, and languages that have appeared in the world during the past two thousand years, the lad of to-day must try to acquaint himself with. Of all these the Athenians knew nothing—could not even predict. When we contrast the life of an American child, from its early school days until the hour it leaves the university or seminary, the many and tiresome hours of study, the endless committing and repeating and forgetting, the confinement in constrained positions, the over-heated and over-dried atmosphere, the newspapers and novels that he is and must be prepared to converse about and criticise, the sermons and lectures which he is compelled to listen to and analyse, the strife and struggle for bread and competence against inordinate competition, the worry and concentration of work made both possible and necessary by the railway, mail-service, and the telegraph; in view of these facts we wonder not that the Americans are so nervous, but rather wonder at the power of adaptation of the human frame for unfavourable environment. The education of the Athenian boy consisted in play, and games, and songs, and repetitions of poems, and physical feats in the open air. His life was a long vacation, in which, as a rule, he rarely toiled as hard as the American lad in the intervals of his studies.

The rapidity of our modern and American life has a tendency to concentrate an enormous amount of activity in a brief space of time. The intensity, the fierceness, and violence of our toil are the results of our climate, and in their turn they deepen and intensify our nervous sensibility. In the study of this subject the disposition has been to look exclusively at some one of these secondary elements—our haste in motion or our haste in eating, and to consider some one such factor as the sole cause of American nervousness. Indeed I may say that up to the present time this has been the popular mode of interpreting the unparalleled phenomena connected with American nervousness. Effects have, indeed, been confounded with causes—a process of reasoning which, it may be added, vitiates and destroys nearly all human philosophy, and nearly on all themes, but especially on questions of sociology, such as the effects of stimulants and narcotics, or diet, or social customs. American nervousness is a complex resultant of a number of factors—not a single result of one. In order to understand it, to grasp it, to master its philosophy, we must be able to see

these factors all at once by themselves, and in their relations to each other.

There is one disease, the type and centre of a large family of functional diseases, to which I have applied the term *neurasthenia*. If we understand the philosophy of this disease and its treatment, there will be little difficulty in understanding the philosophy and treatment of very many of the family of functional nervous diseases to which it belongs. Neurasthenia is pre-eminently an American disease. It might, indeed, be properly called *Neurasthenia Americana*. Although it is found in England and on the Continent, it was here first systematically described, and here it exists in greater variety and frequency than in all other countries combined. The generic term neurasthenia—nervous exhaustion—I subdivide into two: cerebrasthenia—exhaustion of the brain; myelasthenia—exhaustion of the spinal cord.

Among the symptoms that I have referred to *cerebrasthenia* (brain exhaustion) are tenderness of the scalp, cerebral irritation, tenderness and whiteness of the teeth and gums, flushing of the face, special idiosyncrasies in regard to food and external irritants, morbid desire for stimulants and narcotics, insomnia in its varied manifestations, dilated pupils, melancholia or mental depression, deficient memory, or power of intellectual control, different forms of morbid fear, as astrophobia (fear of lightning), agoraphobia (fear of places), anthropophobia (fear of man and society), and its opposite, monophobia (fear of solitude), sick headache, and various forms of headache, and pains in the head, disturbances of the nerves of special sense, as *tinnitus aurium*, and specks before the eyes, subjective tastes and odours, dryness of the skin, eyes, throat, and mucous membranes generally.

Neurasthenia is differentiated from organic disease, by taking into consideration these four elements: (1) The fluctuations and inconstancy of the symptoms; (2) heightened reflex action; (3) the existence of some certain special symptoms, which will really be found in organic spinal disease; such, for example, as different forms of morbid fears, palmar hyperidrosis, excessive tenderness of the spinal cord, deficient thirst, abnormally active pupils, mental depression, extreme insomnia, morbid desire for stimulants and narcotics. In certain organic diseases, it is true, there may be heightened reflex action; but, as a rule, reflex action is diminished in organic or structural disease of the spinal cord. Closely analysed, a large proportion of the symptoms of neurasthenia, as I have before described them, are of a

reflex character coming from the stomach, or some part of the genital apparatus, or, if they are not reflex in their origin, are at least made worse by a reflex irritation. To know this fact, and to act upon it in the treatment of these cases, is indispensable for success. One may treat sweating hands and flushing face and various neuralgias and headache indifferently without any permanent effect, until we attack and destroy the cause; (4) those in whom the nervous diathesis predominates are likely to have functional nervous disease.

In regard to the prognosis in cases of this kind, this general statement is sustained by experience, viz.: All of these cases can be relieved; many of them can be absolutely or approximately cured; but in all cases time and patience are necessary to bring about these results. I have watched these cases for years after they have left off treatment, and I keep up correspondence with patients who have been under my care, and thus have an opportunity to know what the issue is. Patients of this kind live to a good old age—may attain even unusual longevity, and may have their best health during the latter part of their lives. In regard to the details of treatment, I will state but a few facts.

First comes *electricity* in its various modes of application—central, general, and local. In the dosage, we are, in recent years, learning these four facts: 1. That it is sometimes best to use it in exceedingly small doses, mild currents and short applications. 2. That it is sometimes well to use a very strong and painful current. 3. That applications may be protracted for hours in succession. 4. That applications may be made much more frequently than is the general custom. These four propositions apply to nearly all our remedies. In truth, we are widening and deepening the system and range of our therapeutic forces by modifications of the quantity and quality and mode of administration. I have long taught that for spasmodic difficulties, like local sprains of muscles, convulsive tic, facial spasms, &c., very mild galvanic currents are preferable; but I have lately seen a case where very powerful and painful faradic currents, applied with the electric brush, or with the sponge, or both, and with as strong currents as could be borne, were more efficacious than the mild currents. Likewise in sciatica, and even other forms of neuralgia, painful currents that make a blister, or are at least very irritating to the skin, may succeed after mild applications have failed. An electro-puncture directly into the nerve itself will cure when the mild currents are powerless.

The ancients classed the divinities as major, minor—*Dii majores, Dii minores.* Similarly, neurotics may be divided into major and minor remedies. At the head of the major remedies—the *Jupiter omnipotence*—stands, without question, electricity; then comes ergot. That ergot contracts the blood-vessels, and thus is useful in local congestion of the brain and spinal cord, is one of the clearly established facts in physiology, and is one of the few definite, solid foundations for therapeutics; but that this effect on the blood-vessels is all that there is in ergot in its action on the body no philosophical student of nervous diseases would claim. Indeed, this contraction of the blood-vessels must be a result as well as a cause. Behind and beyond all this there is an influence which we cannot analyse. In some instances, very large quantities of ergotine may be given with benefit and without any harm that I can trace. I give ergot for immediate effects, for sick headaches, and for headaches of other kinds, and for long continued action in spermatorrhœa and various other conditions.

Another of these *Dii majores* of neuro-therapeutics is *arsenic* in its different forms. I use, not only Fowler's solution, but de Verlangan's, with also the English preparation of the chloro-phosphide. Arsenic is a remedy the effects of which are not, as a rule, felt at once. It needs to be kept up—to be persevered with for many weeks, oftentimes for many months. A well-known physician of New York was under my care for severe neurosis of the stomach, attended with vomiting of all of his food. Though he ate great quantities, he was growing thin and feeble, and he rebelled against nearly every treatment that had been suggested, or, at least, everything that I gave soon lost its effect. I urged him to use arsenic in small doses; at first he was somewhat averse to trying it, and had made up his mind to go to Europe. For a number of months I did not see him, and supposed he had gone to Europe. A short time since he came to my office and reported that he had tried the arsenic as I had recommended, and that the effect had been immediate, and, with but a slight relapse, up to that time permanent. He had gained in flesh, and regained his power to digest food. The remedy, indeed, acted with specific effect upon him.

Another remedy that perhaps will become, if it is not already, one of the major divinities of neurology, is *cannabis indica.* It is one of the drugs by the proper use of which the treatment of sick headache, for example, has been, within a few years, revolutionised, both for temporary relief

at the beginning of an attack, and during the attack, and as a permanent cure, provided its action is maintained for weeks and months. Its quick and permanent influence over the symptoms of headache suggests its great value in other conditions allied to sick headache, or from which sick headache springs.

Another remedy, not very widely known, but one the value of which is easily proved, is *citrate of caffeine*, and allied to caffeine is *coca*, belonging, indeed, to the same family; indeed, it is the active principle of common coffee, tea, guarana, and chocolate. It relieves the pain and uneasiness that follow over-exertion, and the peculiar distress that comes from sleepless nights, for which purpose, I may say, caffeine may also be used.

The *zinc* preparations, particularly the bromide, valerianate, and oxide are sedatives of very great value in various neurasthenias, and I use them with great freedom. I gave once the zinc combination, including the bromide, the valerianate, the phosphide, and the oxide, to a physician who consulted me about a year ago for neurasthenia, resulting from over work in his profession. In a few weeks he reported himself to me to express his gratitude and to testify to the great value of the remedy as a hypnotic as well as a sedative.

Duboisia, the new remedy from Australia, is likely to take a minor if not a major place among the resources of the neurologist. Its effect is somewhat like that of atropine, but yet not entirely like it; and, for the symptom of hyperdrosis, seems to be more effective according to experiments that I have made with it.

Cimicifugin is a remedy the value of which in choreic condition is undeniable, and I am persuaded that its use need not be restricted to those conditions.

Strychnia is one of our older remedies, and I use it sometimes alone, but very frequently in combination with other remedies; yet it cannot be used in all cases, for sometimes it has a depressing effect.

Opium, in small doses, is excellent for many phases of neurasthenia; and were it not for the danger of forming the opium habit, I should use it more frequently than I do.

Alcohol also, in the form of wine, particularly claret and burgundy, is to be advised in some cases of this kind, but not recklessly, or without reference to the age, character, and temperament of the patient. Alcohol is one of the best of our hypnotics in cases where the bromides fail to produce sleep. Where chloral causes severe headache next morning, claret wine, freely used, may produce satisfactory effects

without any unpleasant after effects. In the treatment of nervous cases, it is sometimes necessary to use all of these potent remedies in incredibly and absurdly small doses.

Dilute nitro-muriatic acid, either alone or combined with the vegetable bitters, I use in different forms of nervous exhaustion, especially where the urine is over loaded, as it often is, with oxalates and urates.

Of *cod-liver oil*, I may say that it probably does more for the nervous than it does for the consumptive. Oil and fats, like cream and butter, are brain food, and if used judiciously, as the stomach can bear them, act both as food and as medicine. The oil I use generally in the form of emulsion, and I use it with great freedom.

Of *phosphates*, this can be said: that they belong to the list of over-praised and over-used remedies. All these stock remedies have a certain power which, in very many cases, they soon expend—they reach the limit of effect, beyond which they cannot be forced.

Another new remedy, or comparatively new to this country, is *koumiss*—fermented milk. The power of this remedy to produce sleep is very great, and very satisfactory. It is a means of nourishing the body without disturbing or even using the stomach to any very great degree. Koumiss is really digested milk, and is absorbed and taken up into the system without any strain upon the digestive apparatus. I am persuaded that the use of koumiss in the future is to be very widely extended for all conditions where nutrition is difficult—not only in adults, but in children. The one disadvantage of koumiss in some cases—that it constipates the bowels—is to be met by laxatives.

Another very old remedy, but as good as it is old, where it is properly used, is counter-irritation, which I employ both in the form of *actual cautery*, and galvanic cautery, and very small blisters, so small and so arranged as to cause very little annoyance. Counter-irritation in the hands of those who really understand how to use it without abusing it, is one of the three or four major remedies of neuro-therapeutics. The actual cautery, as it can be used, and is used by those who understand it, is not specially painful, even to the most delicate woman. The pain is in the idea of the thing—in the expectation, and not in the burning. I speak of this point particularly, because the cautery is an agent of such great therapeutical power. This mode of treatment, like the blisters already referred to, must be, and now can be, modified and adapted to the sensitive modern constitution.

Hydro-therapeutics in the form of bags of hot and cold water, the Russian and Turkish baths, and alternate applications of hot and cold is, in skilful and judicious hands, a great remedy for functional nervous diseases.

It is impossible to speak of the treatment of this class of troubles without referring to the *bromides* of potassium and sodium, and lime and lithium. Bromides may now be classed among the old remedies. Their great value in epilepsy has long been known. They are not, however, so well understood in other nervous diseases of a functional character. The bromides may be used in large doses, frequently repeated until the powerful sedative effect is produced, even when there is no sleeplessness; those who use the bromides in this way must know where to stop or to reduce the dose.

There are a few general principles of treatment of which I will speak. First of all, the proper use of *rest* and *work* in the treatment of nervous disease. About a month ago, a patient with ataxy came to me from a distant city in the West; I said to him, "you have left behind you a better doctor than you can find here." He asked, "Who?" I said "*rest!*" I prescribed it for him, and put him to bed. He had been accustomed to take excessive exercise—at least, far more than was good. The next day another gentleman came, also from a distant city of the West, with the history of a certain form of cerebrasthenia—brain exhaustion—without any myelasthenia, or spinal exhaustion—and of a type that would be benefited rather than injured by a degree of mental and physical activity. He had felt disheartened and thought there was little for him to do in this world. He was of about middle life, and I told him that he probably was no more than "half-way home," and, so far as the disease was concerned, he might live and be active for thirty or forty years longer. When he returned, I said to him, "you have come a long distance to consult me, but you left at home a better physician than you can get here." He asked, "Who?" I said "*work;* work I prescribe for you. Take that in connection with all your medicine and you will recover." These two cases made clear the opposite methods of treatment.

A second and general suggestion is, that of a stopping treatment or suspending it at times. Suspending treatment has a positive effect upon the system. Oftentimes it makes a direct impression, which may be better than continuous treatment. A friend of mine, formerly a sea captain, states that when sleeping in his cabin at night, if the sentinel walking the deck above him stopped, it would always wake

him. The sudden sensation of nervous activity, like a jar upon the nerves, aroused him from his slumber. I find that patients sometimes do better—make more decided progress—in these intervals of treatment than while the most active measures are being used. Patients sometimes imagine this a proof of the valuelessness of the medicines; but it is in reality a proof of their power. It has been said that success in life depends largely upon knowing just where to stop. In the practice of medicine, this maxim is certainly sound; and to know where to stop, to let up, to modify the treatment, is one of the best tests of medical skill.

The third general suggestion is, that in the treatment of nervous diseases, we should study with all our energy the psychology of our patients; we must make a diagnosis of the intellectual character as well as of the disease before we can make a prognosis or adopt a plan of treatment. There are those whose minds are so organised, which lack some qualities and have excesses of others—usually a preponderance of the emotional, with a deficiency of the higher intellectual qualities—that they act badly under any treatment, however wise. Some patients take a pleasure in their distresses; it would be cruel to cure them; their pains are their possessions. Any man wishing to make them well would be no better than a thief or a robber. There are those whose chief felicity in life consists in doctoring and being doctored, and to whom the removal of their bodily ills would be like the death of long cherished friends. When such persons come under your care, you cannot expect any treatment to be as successful as with those strong and active intellects, who understate rather than magnify their troubles, and are resolutely determined to get well.

III. MOVING ROCKS.

A REMARKABLE instance of rocks moving out of water on to dry land is recorded by the Earl of Dunraven in an article on "Moose-hunting in Canada," which which will be found in the July No. of "The Nineteenth Century." The attention of Lord Dunraven was directed to this phenomenon during a visit to Nova Scotia in the fall

of last year, but only a day or two before he left the woods, so he had not time to make any investigation into the subject. A lake of considerable extent, but shallow, was full of great masses of rock. "Many of these masses," observes Lord Dunraven, "appear to have travelled right out of the lake, and are now high and dry, some 15 yards above the margin of the water. They have ploughed deep and regularly defined channels for themselves. You may see them of all sizes, from blocks of, say, roughly speaking, 6 or 8 feet in diameter, down to stones which a man could lift. Moreover, you find them in various stages of progress, some a hundred yards or more from shore and apparently just beginning to move; others half-way to their destination; and others again, as I have said, high and dry above the water. In all cases there is a distinct groove or furrow which the rock has clearly ploughed for itself. I noticed one particularly good specimen, an enormous block which lay some yards above high-water mark. The earth and stones were heaped up in front of it to a height of 3 or 4 feet. There was a deep furrow, the exact breadth of the block, leading down directly from it into the lake, and extending till it was hidden from my sight by the depth of the water. Loose stones and pebbles were piled up on each side of this groove in a regular clearly defined line. I thought at first that from some cause or other the smaller stones, pebbles, and sand had been dragged down from *above*, and consequently had piled themselves up in *front* of all the large rocks too heavy to be moved, and had left a vacant space or furrow behind the rocks. But if that had been the case the drift of moving material would of course have joined together again in the space of a few yards behind the fixed rocks. On the contrary, these grooves or furrows remained the same width throughout their entire length, and have, I think, undoubtedly been caused by the rock forcing its way up through the loose shingle and stones which compose the bed of the lake. What power has set these rocks in motion it is difficult to decide. The action of ice is the only thing that might explain it; but how ice could exert itself in that special manner, and why, if ice is the cause of it, it does not manifest that tendency in every lake in every part of the world, I do not pretend to comprehend."

IV. PETROLEUM AS A STEAM-MAKER.

THERE are said to be 7,000,000 barrels, of 40 gallons each, of crude petroleum now above ground in the oil regions. Every hour adds to this ocean of oil; in spite of the enormous consumption the stock accumulates. Every new use to which petroleum is applied possesses interest to producers, and the day that shall see crude oil take the place of coal as a steam-producer will be a glad day for mankind in general and oilmen in particular. That such a day is not very far distant seems evident after an inspection of the working, recently, of an oil-burning device tested on a river steamer at the Monongahela Wharf. The experiment is thus described in the "Pittsburg Telegraph:"—

The invention is the property of the American Hydrocarbon Gas Company (John Campbell, General Manager), and embraces simple but vital principles of construction, wherein atmospheric air and steam are combined in proper proportions with oil, and injected into the firebox beneath the boilers in the form of spray. The latter, being immediately converted into inflammable gas, becomes a pure, bright, powerful flame, devoid of smoke, and producing intense heat.

To accomplish this result extremely simple machinery is used. A small hole is drilled into the iron front of the firebox, and into this passes a tube which branches as it leaves this point into two pipes. One of these connects with the boiler itself, and the other with the receptacle containing crude oil. At the juncture of these pipes there is an aperture for the admission of outer or atmospheric air. Valves of peculiar construction regulate the quantity of steam or oil admitted to the furnace. This is all the machinery required, but its operation is wonderfully complete and remarkably successful.

The little steamer *Billy Collins* was selected by Mr. Campbell for the test, and was fired up at 9 a.m. A preliminary blaze of wood under the boiler raised the small quantity of steam necessary to start the burner into operation. The oil valve was opened a trifle, the steam valve ditto. The petroleum trickled into the feed-pipe, was caught up by the steam, and both plunged into the depths of the firebox, a mass of many-tongued, roaring, brilliant flame.

As the pressure of steam increased, this flame grew in fury and intense heat, roaring through the entire length of the boiler with a sound like the coming of a thunderstorm. The needle of the steam gauge climbed rapidly up the dial, and in twenty minutes the safety valve blew off at 120 lbs. pressure. It was a remarkable sight. Here was a boat puffing through the water with no sign of smoke from her chimneys, no speck of soot in flues or firebox, no fireman, no opening of furnace doors, no dirt, no coal going in, and no clinkers or ashes to be seen anywhere. A turn of the hand regulated the terrible flame that seemed trying to overpower the limits of the furnace, and another turn of the hand brought the fire down to a quiet little flame, a foot or two long. During the forenoon occupied by the test about 20 gallons of crude oil were consumed; and Mr. Campbell's estimate was, that with oil at one dollar per barrel this fuel was equivalent to coal at six cents in heat-producing value, other things being equal.

But other things are not equal by any means, and everything is in favour of oil as against coal. The labour and expense of "firing up" is dispensed with, and the engineer can regulate the flame as he does the steam in his engines. The danger from sparks and flying cinders is entirely done away with. The space occupied by oil, as compared to an equal value of coal, is very much less, and this much is gained for cargo. Further, the wear and tear upon boilers, grate bars, &c., is infinitely less, and, it seems scarcely necessary to add, the comfort of passengers is greatly enhanced by the absolute freedom from dirt of all kinds.—*Scientific American.*

V. THE MAY TORNADOES OF KANSAS AND MISSOURI.

By Prof. John D. Parker, Kansas City.

ON May 30, 1879, occurred two of the most destructive tornadoes that were ever known to visit the Lower Missouri Valley. This statement is verified, whether we consider the violence of the tornadoes, the extent of territory passed over, the amount of property destroyed, the

number of persons injured, or the loss of life.* These two tornadoes we have named from the towns where they did the most damage, and will treat them as follows:—

The Lee's Summit tornado seems to have originated near Belton, Cass county, Missouri. In the afternoon of May 30, 1879, there was a heavy shower at Belton, accompanied with hail, while further east another heavy storm was raging. Late in the afternoon these two storms seemed to unite to form the tornado, which passed off in a north-easterly direction. At Raymore, Cass county, several persons state that they saw the clouds gradually approach each other, forming two funnels in the air at the same time, which seemed to approach and play around each other, and then unite to form one mighty column, which swayed and rocked to and fro like a huge balloon, with the roaring and rushing of a thousand locomotives, as it passed on its way, levelling everything before it.

At Lee's Summit the people report the weather, on the afternoon of the 30th of May, as very sultry and oppressive, with a warm wind blowing from the south. Toward evening a cold current of air came down from the north-west, accompanied with hail and some rain. About six o'clock a black cloud from the south-west suddenly burst upon them, and the tornado swept by about two miles south of the town. A correspondent, who visited the path of the tornado, reports that everything in the shape of vegetable life was mowed clean, and the ground torn up in places, especially on hill-sides, as if hundreds of men with shovels had dug it up for a road-bed of some giant railroad. The largest trees were twisted off close to the ground like pipe-stems, or taken up by the roots and carried for hundreds of yards, and then dashed to the ground and splintered, in some cases, as fine as kindling wood. Ponderous rocks were hurled from their beds hundreds of yards and broken into fragments. Buildings and fences were swept away, and timbers carried in some instances over a mile and driven endwise several feet into the hard earth. Animals are reported as having been taken up and carried some distance, and let down uninjured.

The people at Blue Springs, about twelve miles north-east of Lee's Summit, liken the tornado to a huge tower of inky

* I take pleasure in acknowledging my obligations to various persons for assistance furnished in reference to the May tornadoes, especially to Dr. F. A. Ballard and Mr. Charles H. Clark, of Independence, Missouri, and to Dr. Isaac B. Smith, of Frankfort, Kansas, and also to Miss Kate Slosson, a pupil of Mrs. Clara Hoffman, Principal of the Lathrop School, Kansas City.

blackness reaching to the sky, preceded by a fearful rushing and roaring noise, the mass of the ascending column being perfectly opaque. Passing south of Blue Springs nothing could withstand the violence of the tornado, the most substantial houses in the vicinity of that place being swept away in a moment. Numerous instances are given showing the violence of the storm. The mould-board of a plough was wrenched off and carried some distance; a new waggon was wrecked, the spokes being wrenched from the hubs, and the tires bent into a variety of fantastic shapes. Trees were stripped of their bark and looked as if scorched, which phenomena was first attributed to electricity, but afterwards found to be a discolouration by a peculiarity of the sap. Prostrated trees were found lying some at right angles to the path of the tornado, and some pointing toward the vortex. Evidences are abundant that the funnel of the tornado contained a large amount of *débris*, and mud having a sulphurous odour, which was dashed with tremendous force and plastered over every obstacle remaining in the path of the tornado. A fence near Blue Springs, running east and west, was thrown down, the west end toward the south, the east end toward the north, showing the direction of the currents. A short distance beyond Blue Springs the tornado seemed to be lifted from the earth, not doing any more damage.

A correspondent, going from Blue Springs to Lee's Summit, says that for several miles the road runs along almost parallel with the track of the tornado, which was nowhere more than three hundred yards in width, and in some places was contracted to fifty yards. Some persons escaped who were caught in the tornado, although instantly blinded, stunned, and covered with mud, and carried they knew not whither. The path of the tornado was deflected a little, about three miles south-west of Blue Springs. It seemed to sweep over hills and ridges and through ravines alike, carrying everything before it. It is impossible to give the mass of particulars gathered for this article, and many reports must be taken *cum grano salis*. Some four persons were reported killed, and a large number injured, some perhaps fatally. A correspondent traced the track of this tornado, giving range for the path examined of nine miles east and twenty-one miles north. The tornado passed along an elevated portion of the country, or a divide, the heads of streams along its course flowing from it both east and west. One of the U.S. Signal Corps observers, I learn, traced the path of this tornado back nearly to Paola, in Kansas.

XUM

The Irving tornado had its origin probably as far west as Ellsworth county, Kansas, and crossed the Saline river at the mouth of Twelve-Mile Creek, where it did its first damage. It travelled in a north-east direction, through Lincoln, Ottawa, Clay, Riley, Marshall, Nemaha, and Brown counties, and passed into Richardson county, Nebraska. The same general storm touched Cawker City and Beloit, Mitchell county, Kansas, at about 2.30 p.m., unroofing at the latter place the tent of a circus which was in full blast, blowing down a number of houses, and twisting large trees in pieces as it passed down the Solomon river; this storm being, perhaps, an outlier or feeder of the main tornado. The Irving tornado passed about four miles south of Delphos, which has since been almost destroyed by another tornado, June 9, 1879.

After passing the Solomon river, the Irving tornado seemed to increase in violence and destructiveness. Some describe its appearance in its approach as "cloudy pillars" resembling smoke, afterward assuming an inky blackness, all rolling, dashing, and clashing with each other, as if engaged in a furious battle. The tornado struck Stockdale, Riley county, doing some damage, whence it passed on, crossing the Blue river, lifting all the water out of the bed of the stream, and scooping the water, it is said, out of a well.

The people at Irving saw, just before 5 p.m., a dark mass of clouds gathering south-east of the town. A deep roar was heard, when the clouds began to lower and spin like a top, advancing upon the town and destroying one small house in the outskirts. This seemed to be a prelude, followed by a calm. Suddenly the heavens turned a greenish hue, and, with an awful roar, the tornado burst upon them, leaving the southern portion of the town a mass of ruins.

The tornado then swept onward, with a path from one-half to three-fourths of a mile in width, and when within two miles of Frankfort it passed up the west fork of the Vermillion river, in a north and north-east direction, a distance of fifteen miles, near Axtell, where it turned again upon its normal path and passed on near Sabetha, and into Richardson county, Nebraska. About fifty houses were blown down in the vicinity of Frankfort, and fifty families left destitute.

During the passage of the tornado neighbouring towns received more or less damage. Vermillion suffered slightly, some of the houses being started from their foundations.

Centralia, Blue Rapids, and Waterville received some damage.

I give some singular incidents of the tornado, as related on good authority:—

Mr. Fitch's son was blown across a ravine, over trees and fences, and landed unhurt on the door-step of a house half-a-mile distant. When asked how he came there, he replied, "I do not know!" Mr. Yawger found one of the wheels of his waggon 2½ miles from home. A tire was blown off a waggon wheel and straightened out as well as a blacksmith could do it. The body of a lady was driven into the ground head foremost, covering head and shoulders. A coat was torn from one man, divided in the centre, the halves being driven in opposite directions. Some of the fowls were picked clean of their feathers. On Snipe Creek, large elm, oak, walnut, cottonwood, and sycamore trees were twisted off and torn up by the roots, leaving a fine forest a scene of desolation.

The number of killed and injured have been variously estimated. At Irving and vicinity, thirteen were killed and fifty wounded. At Frankfort and vicinity, five were killed and forty injured. At Delphos and other places large numbers are reported killed and injured. The people along the route of the tornado were engaged in little else for several days but in burying the dead and caring for the wounded.* In Marshall county alone the damage to property and crops is estimated at 150,000 dollars.

On May 29, 1879, occurred a destructive tornado in Andrew and Nodaway counties, Missouri. A correspondent says, on that calendar day, at Bolckow, Andrew county, a hot wind blew from the north-west for several hours. The skies had been overcast from early morning with clouds, which frayed off and separated into light-coloured masses and drifted away, and finally dissolved in the atmosphere. About three o'clock clouds banked in the west and north-west in heavy black masses, and a current of hot air from the south-west appeared to hurl them in wild wreaths like battle clouds on one another. About four o'clock the citizens were startled by seeing a wild funnel-shaped cloud appear in the west, and sweep onward as if to doom their town to destruction. Its muffled thunder-roar was soon distinctly heard, and immediately it swept by the town upon

* Immediately after the occurrence of the Irving tornado, Governor St. John issued a proclamation calling on the people of Kansas to render assistance to the sufferers, heading the subscription himself with a liberal contribution, and all has been done that is possible to relieve the sufferers.

its destructive mission. The track of the tornado lay about three miles north-west of the town, and presented the looped and ragged edge, so often seen in tornadoes, on the south side. Observers say the tornado at times seemed to stop and take a backward turn, and then sweep on with renewed force. In this manner the tornado would destroy alternate pieces of property, leaving, perhaps, a house standing in the loop unscathed. The tornado passed about a mile north of Barnard, Nodaway county, and, when last observed, was moving toward Conception, Nodaway county. The violence of the tornado was very great; large trees, two and three feet in diameter, were twisted off, and the most substantial houses were lifted into the air and dashed in pieces. In one place it swept through a ravine, lifting out of its narrow walls every stick of timber, so that the bed of the ravine seemed to have been swept with fire. The northward tendency of this tornado in translation was probably due to surface currents.

Samuel W. Rhode, U.S.A., Sergeant of the Signal Corps, of Leavenworth, has kindly furnished notes, from the journal of that station, on the storm of the 29th of May, which are as follows:—

"This evening one of the most severe storms that has visited this section for several years past passed over this station. During the afternoon the sky was partially, and sometimes fully, covered with heavy, cumulus-stratus cloud, moving rapidly from the south-west. The wind was blowing briskly from the south, with a low and steadily falling barometer and rising temperature. At 5 p.m. a heavy dark mass of 'thunder heads' appeared on the north-west horizon, and gradually moved eastward, increasing in bulk and extending toward the zenith. Frequently, during the formation and development of the storm cloud, as many as four different currents in the air were indicated by the movement of the clouds. The 'cyclone,' or spiral, motion of the wind was plainly discernible in the clouds for over an hour before the force of the storm was felt at the surface. Rain could be seen falling to the north of the station for ten minutes before there was any precipitation here. It looked like vast and dense volumes of fog impelled eastward at a high velocity. At 6.35 p.m. a few scattering drops of rain began to fall. At that time the heaviest portion of the cloud was directly north of the station, the apex being about 60° above the horizon, the wind blowing in fitful gusts from the south. At 6.58 p.m. the barometer reached its lowest point, the actual reading (corrected for temperature and instrumental

error only) being 28·670. At 7 p.m. the wind suddenly backed from south to north and increased in force, blowing for about five minutes at the rate of 60 miles per hour. The cloud then moved rapidly southward, trending toward the east. The rain fell in perfect torrents for near an hour. From 7.10 to 7.40 p.m. considerable hail fell: a number of stones were measured and averaged from ¼ to ⅜ of an inch in diameter. The electrical discharges were very intense and almost constant. The force of the storm expended itself about 8.5 p.m. The rain ceased at 8.15 p.m., and the amount which fell in one hour and forty minutes was one inch and forty-three one-hundredths.

"The storm produced no serious damage in this city or vicinity. A large number of trees in the city were blown down, and several large buildings suffered damage by lifting of roofs. Fruit trees and growing grain were somewhat damaged by the hail. The position of fallen trees, in different portions of the city, plainly indicated the spiral motion of the wind. The large iron bridge over the Missouri river at this point, on which was a train of heavily laden cars, swayed so much that the engineer jumped from his engine, thinking the bridge was toppling over.

"At about the same hour, a very destructive tornado struck the earth north of this station, near St. Joseph, Missouri. No doubt the disturbance felt here was an offshoot of the above mentioned tornado.

"During the evening, from 9 to 11 p.m., the electrical display in the south, south-east, and east was very beautiful and vivid. The heavens were almost continually illuminated. Frequently there were seen as high as a dozen streaks of lightning, of the *zig-zag* form, which seemed to radiate from a common centre."

Several theories have been advanced in reference to the causes of tornadoes. In the present article I have only space to discuss one of them.

Storms are supposed to find their origin, according to the Thermal theory, in an unstable equilibrium of the atmosphere due to solar heat. About three-fourths of the sun's rays pass through the atmosphere, and are absorbed by the surface of the earth. The envelope of the earth is thus heated mainly at the bottom, while it loses most of its heat by radiation at the top. As an increase of heat diminishes the density of the air, the envelope of the earth is in a constant state of unstable equilibrium. The upper and heavier strata of the atmosphere tend constantly to descend and force up the lower strata. Vertical currents are thus formed over greater

or less areas of the earth's surface by solar heat every day. The vapour contained in the air is thus carried up by the ascending current until it is condensed into cloud by the expansion and cooling of the air which contains it. The latent heat of the vapour thus liberated tends to elevate the temperature of the air containing it, causing it to be lifted to still higher altitudes. The violence of this upward movement is largely due to the amount of vapour, or the "steam power of the air."

The centre, or core, of a storm sometimes becomes a tornado, which possesses a linear or gyratory movement. Connected with these there is a swaying movement, caused by obstacles, such as hills and forests, along the path of the storm, and sometimes the tornado seems to be drawn up into the air.

I have noticed quite a number of whirlwinds observing the laws of tornadoes. In 1872 I saw a beautiful whirlwind at Burlington, Kansas. While walking toward the town from the north-west, I heard a rushing sound south-west of me. Soon I saw the prairie grass swaying violently, and I had a perfect view of a miniature tornado, as it passed across the road a few rods ahead of me. The atmosphere was tranquil at the time. Here was a whirlwind ploughing its way through a tranquil atmosphere at the rate of ten miles an hour, moving east by twenty degrees north, and gyrating in a direction contrary to the hands of a watch.

Tornadoes in the northern hemisphere are translated toward the east by about twenty degrees north. Deflections from this direction are supposed to be occasioned by local causes, such as rivers, surface currents, &c. The Irving tornado was deflected from its path near Frankfort, passing up the west fork of the Vermillion river, in a north and north-east direction, a distance of fifteen miles, when it again resumed its normal path. North of the equator, tornadoes revolve in a direction contrary to the sun, or the hands of a watch with its face upward, while south of the equator they revolve in an opposite direction.

Tornadoes, according to this theory, originate in disturbing causes acting suddenly, but take their character from the cosmical conditions of the globe. The average temperature of the globe is about 85° at the equator, decreasing to about zero at the poles. This excess of heat expands the air in the equatorial regions, which flows over toward each pole. The larger portion of this circulation, however, is confined to a belt not extending beyond the thirtieth parallel of latitude, because the current is cooled in the upper regions, and the meridians narrow toward the poles.

As the atmosphere is carried around with the earth in its daily revolution, the greater the elevation the greater the velocity eastward. A stream descending from the upper regions of the atmosphere would be impelled by its inertia when it reached the earth in an eastward direction. As parallels of latitude decrease in diameter from the equator to the poles, every parallel, going from the equator, revolves with less velocity than the preceding one. Should a portion of the atmosphere become saturated and unduly heated at the surface of the earth, it would be forced up by colder and heavier air. Currents of air would be formed blowing toward a common centre. In the northern hemisphere those from the north would naturally find the centre moving eastward with a superior velocity, and, falling behind, be projected toward the west, while those from the south would find the centre moving eastward with an inferior velocity, and be projected toward the east. The north half of the tornado would be impelled westward, and the south half eastward, establishing the whirl or vortex, which is a low barometer. The currents descending into the vortex on the south side having a greater impulse eastward, from the earth's rotation, than the impulse of the currents westward descending on the north side, the tornado would be deflected toward the northeast. The liberation of the latent heat by the condensation of the vapour would be the "steam power of the air" to drive up the ascending current; large amounts of electricity would be developed for destructive purposes, and the tornado would sweep on its path to overwhelm towns, crush forests, lick up rivers, and make the solid earth tremble.

The Thermal theory only uses heat, under cosmical conditions, as the *motive* power, leaving much of the phenomena to be accounted for by electricity and other destructive agencies.

Modesty should cover all theories of these awful but occult visitors like a garment. A few golden threads are in our scientific fingers, but the theoretic fabric for tornadoes is still largely to be woven. Do not let us imitate that great German scholar, who in his mature years found the works of his earlier life the hardest to answer.

There need not be any special alarm about tornadoes. Like great comets, they seldom appear, but on that account are the more noticeable. Destructive tornadoes only occur during dry seasons, and then, in this latitude, only on the last few days of May or on the first few days of June. The greatest tornado on record occurred June 3, 1860, the year of the drought. It passed over a large portion of Iowa and

Illinois, destroying Camanche, and killing fifty persons. That would not be an unusual railroad accident or ocean disaster. We stand a hundred chances of being killed in ordinary travel to one chance of being killed by a tornado. Still, we take our sleeping berth and fall into a quiet slumber. Tornadoes also occur just before evening, and, if we remember the law of their movement, we can generally escape them. Although, then, we may never be killed by a tornado, still it is always well to keep a clear conscience.—*Kansas City Review of Science and Industry.*

VI. THE PIRATE'S SHEET-ANCHOR.

THE common-sense doctrine that the right of an inventor to the creations of his own mind is the most natural and sacred of all kinds of property, though substantially self-evident, is far from meeting universal acceptance. That our ancestors in their ignorance ranked copy-right and patent-right among "monopolies"—just as they classed the whale among fishes, and confounded astronomy with astrology—is an unfortunate circumstance, which cannot, it seems, be forgotten. In a political economist the very word brings on a state of fury bordering on madness. Call any institution, right, or possession a "monopoly," and he strives to destroy it without further question.

For the benefit of persons capable of judging soberly and righteously, it may be well to examine the ostensible grounds on which pirates rely when they proclaim patent-right not property, but a mere privilege.

Their first argument is one which it is simply astonishing, and even painful, to hear from any man of mature age and good education. It is in substance this, that as an invention is often sought after or aimed at, and sometimes even attained, by several persons simultaneously, it cannot, when completed, be considered the property of any person! That we may not be accused of unfairness I will use the very words of the piratical school, as given in the "Dictionary of Science, Literature, and Art," by W. T. Brande and Rev. G. W. Cox (article "Patents," vol. ii., p. 834). The article in question appears to be from the pen of Professor Thorold Rogers, though we have no right to assume that the views expounded are his own, since he introduces them

with the words "It is alleged." We are there told that "simultaneous discovery is the rule, independent invention the rare exception; that, in fact, a patent is ordinarily assigned to the mere accident of priority, to the detriment of others who have as effectively found out the power or the process appropriated."

Mr. R. A. Macfie, in his recent work "Copyright and Patents for Inventions" (Preface, v. and vi.), writes—"An invention may be, and commonly is, originated by a plurality of persons in complete independence and ignorance one of another, and of what each other does or has done."

The present writer cannot for one moment admit the validity, or even the relevance, of this contention. The champions of piracy admit, as we see, that in a minority of cases, at any rate, an invention originates from a single individual exclusively, no other person having been searching or experimenting in the same direction. In such cases, then, the argument entirely fails, and the invention, for anything our opponents have yet advanced, must at once be classed as property.

But further, the assertion that "simultaneous discovery is the rule" must be termed a grave exaggeration, improbable on *a priori* grounds, and questionable as regards the evidence upon which it rests. If we consider what multitudes of known and admitted desiderata exist in addition to the vastly greater number of instances where the room for an invention exists unrecognised; if we reflect, moreover, that the solution of each such industrial problem, chemical or mechanical, may be attempted or even effected by a plurality of methods, we shall see that there is a great antecedent improbability in the notion of a number of independent inventors simultaneously originating the very same novelty. We are well aware that when a certain want or difficulty is felt, inventive minds will naturally turn their efforts in that direction. But as a rule, in as far as they are *bonâ fide* inventors, though in pursuit of the same object they will proceed by different ways. Of this truth the history of modern invention furnishes some striking instances. The beautiful dye known as "malachite green" has been obtained simultaneously, or nearly so, by two distinct chemists "in complete independence, and perhaps ignorance, one of another," and on superficial examination this case might seem to tell in favour of Mr. Macfie and his friends. But if we look more closely into the matter we shall see that Doebner, of Berlin, prepares his malachite green by the joint action of dimethyl aniline, chloride of zinc, and benzo-trichloride. Fischer, of

Munich, on the other hand, obtains the same dye by the reaction of dimethyl-aniline, chloride of zinc, and the oil of bitter almonds. Thus when rightly considered the inventions of these two chemists, though relating to the same substance, were distinct.

We may take another signal instance, which though belonging to the sphere of scientific discovery rather than technical industrial invention, still illustrates the same principle.

Not very long ago two eminent physicists, M. Cailletet and M. Pictet, succeeded almost simultaneously in condensing into a liquid state the permanent gases formerly so considered. But here, again, though the end gained was identical, the means employed were distinct. In this manner close and intelligent scrutiny will be found to dispose of a very large proportion of the alleged cases of simultaneous invention.

In another very numerous class of cases the simultaneity, or rather the invention altogether, is doubtful or spurious. There are a certain class of persons addicted to vague and aimless experimentation, whether chemical, physical, or mechanical, on any subject that engages public attention. Twenty years ago they were "messing about" with aniline, napthaline, and phenol, and obtaining products which they had not the skill and the perseverance to purify. Five years ago they were deep in the mystery of roller-skates, and now the electric light has dazzled their minds with its brilliance and its future. When a real improvement is originated in the matter with which such muddlers are engaged, it is very easy for them to say, and perhaps to think, that they too had tried the very reaction or combination in question, and in a few more weeks' or months' time they could have brought their ideas to perfection. It is hard to disprove such assertions. Oftentimes a claimant of this stamp can even prove that at the time in question he was working with such or such substances. But all this generally falls far short of a demonstration that an invention identical with one just claimed in a patent has been independently and distinctly originated by some other experimentator. It is very significant that these multiple or reiterated inventions arise only after some man of merit has paved the way. When Mr. Perkin brought out his original aniline violet no rival inventor complained of having been beaten by a neck. A few years later every fresh aniline dye became a bone of contention between candidates for priority.

Summing up the above considerations we find, therefore

that one class of inventions is confessedly single in its origin; that in another the simultaneity of origination is only apparent; and that in a third it is spurious or doubtful. Thus, contrary to the view stated by Professor Rogers, a mere exceptional minority remains, where, save in point of time, a second person has an equal claim to the authorship of the invention. But even as regards this minority, the argument under examination proves nothing. Let us suppose that two chemists had independently and simultaneously effected the combination of atmospheric nitrogen with hydrogen so as to produce ammonia and ammoniacal salts at a greatly reduced cost. Let us further assume that each had arrived at this result by exactly the same process. In such a case the honour would fall equally to both. The beneficial interest in the invention, in default of omniscient patent-commissioners, falls to the one who first took date by petitioning for letters patent. This arrangement may not agree with the dictates of ideal equity, but is probably as near an approximation as is possible in human institutions. That A has completed an invention in January, and that B has independently originated the same invention in February, can certainly never justify C—the pirate, or idea stealer—in saying that it is therefore the property of neither. The "accident of priority," if accident it can be legitimately termed, is in many cases the very point upon which admitted property hinges. The mere fact that E is the eldest of the sons of D ensures his succession on the death of D to the real estate of the latter. Nor is the existence of primogeniture ever advanced as a reason why land should not be regarded as property.

In the case of islands or regions previously unknown, priority of discovery, registered by hoisting the national flag, has always been considered as giving the title to possession. Suppose that two ships, commissioned by different powers, were each in turn to discover one and the same guano island, no one would contend that the second discoverer was in any way "prejudiced" or entitled to call in question the right of his anticipator. Still less would it be argued that, because the island had been independently discovered by the vessels of two powers, it could become the property of neither.

A case still more closely analogous is afforded by the mining laws and customs of certain districts. Two or more persons may independently and almost simultaneously have become aware of the existence of an unclaimed and unwrought vein of tin or copper ore. But it becomes the pro-

perty, subject to the payment of certain dues, of the man who first breaks ground. No one contends that his right is "to the prejudice" of the second discoverer, or blames him as a "monopolist," yet the mine is less truly the property of the finder than is the invention of its originator. The vein of ore had a prior existence, while the invention had not. These considerations will, we think, satisfy every disinterested man of the utter futility of the piratical argument drawn from the alleged simultaneity of invention.

Another ground brought forward for denying to inventors the character of property has been expressed as follows:—"What he (the landowner, or the fundholder, or, we suppose, the successful gambler) occupies, is something tangible and limited which *can* belong to him without his requiring to go out of his way or into any other person's way in order to watch it, work it, and profit by it. *True property* is manifestly a right to an existing thing, visible and palpable, that only a single person, or at the most a limited number of persons, can hold, occupy, employ and enjoy."

Here again the attempt to establish a difference between patent-right and property utterly fails. A patent, just like an estate, is generally in the hands of one person, and, just as the landowner can sell or let the whole of, or certain fractions, of his domain, so the patentee can assign or let the whole of his interest to one person or to a number. There is the closest analogy between the two cases.

Again, we admit that a patent is in itself nothing "visible, tangible, or palpable." But the same may be said of various kinds of recognised property. A. B. holds, for instance, ten shares in a manufacturing or banking company, or a thousand pound's worth of consols or of Egyptian bonds; where in these cases is the "existing thing visible and palpable?"

If this "existing thing" be the share certificates, they are simply analogous to the patentee's official document. The patentee, no more and no less than the landowner or fundholder, has to "go out of his way or into any other person's way" to watch, work, or profit by his possession. Other persons and their ways the inventor leaves as he finds them, except they wilfully and knowingly come out of such ways in order to trespass upon his novel creation. It is sometimes, with admirable simplicity, contended that patent-right is a privilege in restraint of trade. This is what every thief might say of the institution of property; it restrains him, to his great annoyance, from carrying off and selling his neighbour's goods and chattels.

There may be sometimes greater difficulty in defining the

rights of a patentee than those of a landowner, though the boundaries, water-rights, and easements of estates have been a fruitful source of litigation. But if we, on that account, decline to recognise property in invention, we follow the example of a certain examinee—we will not say student—who, being unable to classify certain mineralogical specimens, got over the difficulty by throwing them away.

If the advocates of free-booting still refuse to recognise the property of the inventor in his creation, they should at least produce some more pertinent arguments in defence of their position. It is mainly by priority in invention that England's old industrial supremacy was gained, and if it is to be retained, or rather re-conquered, invention alone can point the way. A Bessemer, a Siemens, or a Perkin, is of more value to the country than all the professors of political economy and all the chambers of commerce that ever existed.

VII. THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Sheffield Meeting.

THE Meeting of the British Association at Sheffield, which closed on the 28th ult., though not so largely attended as the Dublin Meeting of last year, proved a very successful one. The arrangements of the Local Committee, of which Dr. H. C. Sorby, F.R.S., and Mr. J. F. Moss were the Secretaries, gave great satisfaction, and never has the Association been received with greater hospitality than by the Mayor and inhabitants of Sheffield.

At the concluding meeting it was announced that the grants of money appropriated to scientific purposes by the General Committee amounted to £960. The following is a list of the grants:—A. Mathematics and Physics: Dr. Lodge, new form of high insulation key, £10; Prof. Adams, standard of white light, £20; Prof. Everett, underground temperature, £10; Dr. Joule, determination of the mechanical equivalent of heat, £50; Sir W. Thomson, elasticity of wire, £50; Mr. Glaisher, luminous meteors, £30; Mr. G. H. Darwin, lunar disturbance of gravity, £30; Prof. Sylvester, fundamental invariants, £50; Mr. J. Perry, laws

of water friction, £30; Mr. W. E. Ayrton, specific inductive capacity of Sprengel vacuum, £20; Rev. Prof. Haughton, completion of tables of sun-heat co-efficients, £50; Prof. G. Forbes, instrument for detection of fire-damp in mines, £10; Mr. J. M. Thompson, inductive capacity of crystals and paraffines, £25. B. Chemistry: Dr. Dewar, spectral analysis, £10; Dr. Wallace, development of light from coal gas, £10. C. Geology; Prof. Duncan, R.M., report on carboniferous polyzoa, £10; Prof. A. L. Adam, caves of South Ireland, £10; Prof. Seeley, viviparous nature of ichthyosaurus, £10; Mr. John Evans, Kent's cavern exploration, £50; Mr. John Evans, geological record, £100; Prof. W. C. Williamson, miocene flora of the basalt of North Ireland, £15; Prof. Hull, underground waters of Permian formations, £5. D. Biology: Dr. Pye Smith, elimination of nitrogen by bodily exercise, £50; Mr. Lane Fox, general anthropological notes, £20; Mr. Stainton, record of zoological literature, £100; Dr. M. Foster, table at zoological station at Naples, £75; Dr. A. Gamgee, investigation of the geology and zoology of Mexico, £50; Sir J. Lubbock, excavations at Port Stewart, £15. F. Statistics and Economical Science: Dr. Farr, anthropometry, £50. G. Mechanics: Mr. Bramwell, patent laws, £50. Total, £960.

On the motion of Mr. Sclater, seconded by Prof. Ramsay, it was resolved that the Council be authorised to take such further action, having regard to the correspondence with the Treasury as to the natural history collection, as they may deem necessary in the interests of science.

The following is an abstract of the Inaugural Address of the President, Prof. G. J. ALLMAN, M.D., LL.D., F.R.S., &c.:—

The PRESIDENT selected as his subject the most generalised expression of living matter, and gave an account of the results of the latest researches into its nature and properties. Some forty years ago, he said, Dujardin pointed out that the bodies of some of the lowest animals consist of a structureless semi-fluid, but contractile substance, which he named Sarcode. Mohl afterwards detected and studied a similar substance in the cells of plants, which he called Protoplasm. Schultze subsequently demonstrated that these two substances, the sarcode of animals and the protoplasm of plants, were identical. Recent research has not merely confirmed this conclusion of Schultze, but has shown that protoplasm lies at the root of all vital phenomena, whether animal or vegetable, constituting, as Huxley expresses it, the "physical basis of life." Wherever there is life there is

protoplasm, and conversely wherever there is protoplasm there is life.

Co-extensive with the whole of organic nature—every vital act being referable to some mode or property of protoplasm—it becomes to the biologist what "ether" is to the physicist, only that instead of being a mere hypothetical conception, accepted as a reality merely from its adequacy in explaining phenomena, it is a reality, visible and tangible.

The chemical nature of protoplasm is very complex, and not yet fully determined. It is, however, a combination of albuminoid bodies, its main elements being oxygen, carbon, hydrogen, and nitrogen. In its typical state it is a tenacious glairy liquid, in consistence something like the white of unboiled egg. Under the microscope it displays movements. Waves traverse its surface, or it is seen to flow away in streams of the most varied characters, not only in accordance with gravity, but in directions utterly opposed to gravitation. All these movements take place without any obvious impulse from without which might send ripples over its surface or set streamlets flowing from its margin. These phenomena are such as we never meet with in a simply physical fluid; they are spontaneous movements due to its proper irritability, to its essential constitution as living matter. On still closer examination it is found, if not absolutely homogeneous, still totally destitute of structure. It is a living liquid, which, though organless, manifests the essential phenomena of life.

Such is protoplasm in its most generalised aspect. The speaker then proceeded to give some examples of protoplasm as actually met with in Nature. He described the far-famed *Bathybius*, first dredged up in the North Atlantic by the naturalists of the exploring ship *Porcupine*, from depths of 5000 to 25,000 feet. This substance has been examined by Huxley and Haeckel, who pronounce it to be living protoplasm in its simplest and most primitive condition. On the other hand, the *Challenger* explorers met with no traces of this living matter,—for it can scarcely be called a living being,—and they conclude that it is merely a deposit of sulphate of lime, inorganic, and of course inanimate. Bessels, however, the naturalist of the *Polaris*, confirms the views of Huxley and Haeckel, and states that he dredged up from the Greenland Seas masses of protoplasm, living, but undifferentiated. Further research is here, therefore, required.

As a further and indisputable form of protoplasm we have *Protamœba primitiva*, little living lumps which multiply by spontaneous division.

A little higher is the *Amœba* of our pools and gutters, a being without definite shape, perpetually changing its form, throwing out and drawing in thick lobes and finger-like "false feet," in which its body seems to flow over the field of the microscope. It is no longer a mere homogeneous particle of protoplasm, like

the *Protamœba*. Towards its centre a small globular mass of firmer matter has become differentiated from the remainder, forming a nucleus, while the protoplasm constituting the extreme outer boundary differs slightly from the rest, being more transparent, destitute of granules, and apparently somewhat firmer than the interior. We may also notice that at one spot a clear spherical space has made its appearance. On watching we see it suddenly contract and vanish, and after a few seconds it dilates, comes into view, and again disappears,—all this in regular rhythmic sequence. This pulsating cavity is the "contractile vacuole." In the *Amœba* we have the essential characters of a *cell*, the morphological unit of organisation and the physiological source of specialised function. The term "cell" is, however, somewhat misleading; it denotes merely a definite mass of protoplasm containing a nucleus, which may or may not assume the form of a vesicle. To the non-nucleated forms of life, such as *Protamœba*, Haeckel assigns, in distinction, the name Cytode. Many aquatic beings beside the *Amœba* never pass beyond the condition of a simple cell, in which reside the whole of the properties which manifest themselves in the vital phenomena of the organism. As we pass from these lowest forms to higher we find cell added to cell, until many millions of such units become associated in a single organism, where each cell or group of cells has its special work, while all combine for the welfare and unity of the whole. Still even in man the component cells are far from losing their individuality. The colourless blood-corpuscules retain most of the characters of the *Amœba*.

The animal egg, which in its young state forms an element in the structure of the parent organism, is a true cell, consisting of a lump of protoplasm enclosing a nucleus, and having in the interior of this a nucleolus. Whilst still very young it has no constant form, and may, like an *Amœba*, wander about by the aid of its pseudopodial projections. The life of an organism is made up of the lives of its component cells, and here we find most distinctly expressed the great law of the physiological division of labour. In the lowest unicellular organisms the performance of all the processes which constitute its life must devolve on the protoplasm of this one cell; but as we pass to more highly organised beings the work is distributed among a number of workers,—to wit, the cells which make up the complex organism. No cell, however great may be the differentiation of function in the organism, can dispense with its irritability, the one constant and essential property of every living cell. In very many instances the protoplasm becomes confined within resisting walls, composed in plants of cellulose, still losing none of its activity, as is manifest in the Characeæ, in *Valisneria spiralis*, and even in higher plants. Even in these higher plants, further, truly naked protoplasm still occurs, as has recently been shown by Mr. F. Darwin in the teazel (*Dipsacus*)—a phenome-

non probably connected with the absorption of nitrogenous matter.

That there is no essential difference between the protoplasm of plants and of animals is rendered plain by a number of motor phenomena which we have been in the habit of erroneously regarding as peculiar to animals. All living protoplasm alike possesses the property of resisting the entrance of colouring-matter into its substance, though as soon as dead it can be coloured throughout.

Recent researches on the division of animal cells show how close is the agreement between plants and animals in all the leading phenomena of cell-division, and afford further proof of the essential unity of the two great organic kingdoms. The egg, as a typical cell, distinguishable by no tangible characters from thousands of other cells, is nevertheless destined to run through a definite series of developmental changes which have as their end the building up of an organism like that to which the egg owes its origin. It is obvious that such complex organisations as thus result can be derived from the egg-cell only by a process of cell-multiplication. The birth of new cells derived from the primary cell or egg thus lies at the basis of embryonic development. It is here that the phenomena of cell-multiplication in the animal kingdom can be most successfully observed.

The PRESIDENT then briefly described the so-called "cleavage" of the egg, which is merely a multiplication of the egg-cell by repeated division. The egg has its protoplasm and its nucleus, and is, as a rule, enveloped in a delicate membrane. The protoplasm forms the vitellus or yolk, and the surrounding membrane is called the vitellary membrane. The division about to take place is introduced by a change of form in the nucleus, which assumes the shape of a spindle precisely as in the cell-division of plants. On each pole of the spindle transparent protoplasm collects, forming here a clear spherical area. Each pole of the spindle has become the centre of a system of rays, which stream out in all directions into the surrounding protoplasm. The protoplasm thus shows enveloped in its mass two sun-like figures, whose centres are connected to each other by the spindle-shaped nucleus. To this, with the sun-like rays streaming from its poles, Auerbach gives the name of "Karyolitic figure." A phenomenon very similar to what occurs in cell division among plants now shows itself. The nucleus becomes broken up into a number of filaments which lie together in a bundle, each filament stretching from pole to pole of the spindle. In its central point each filament shows a knot-like enlargement, and from the close approximation of the knots there results a thick zone of protoplasm in the equator of the spindle. Each knot soon divides into two halves, and each half recedes from the equator and travels along the filament towards its extremity. When arrived at the poles of the spindle each set of half knots

coalesces into a globular body, while the intervening portion of the spindle gradually disappears. Instead of the single fusiform nucleus whose changes have thus been traced, we have two new globular nuclei. The egg now begins to divide along a plane at right angles to a line connecting the two nuclei. The division is introduced by a constriction of its protoplasm commencing at the circumference just within the vitelline membrane, and extending towards the centre, divides the whole mass of protoplasm into halves, each including within it one of the new nuclei. Each of these two young cells divides in its turn in a direction at right angles to the first division-plane, while by continued repetition of the same act the whole of the protoplasm or yolk becomes broken up into a vast multitude of cells, and the unicellular organism—the egg with which we began our history—has become converted into an organism composed of many thousands of cells.

In the greater number of plants the protoplasm of most of the cells exposed to sunlight undergoes an important differentiation, part of it becoming separated from the remainder in the form of green granules known as chlorophyll granules. These consist of true protoplasm, as the green colouring-matter may be extracted, leaving behind the colourless protoplasmic base. That chlorophyll is a living substance is sufficiently obvious. On the cells which contain it devolves the faculty of decomposing carbonic acid. On this depends the assimilation of plants—a process externally manifested by the exhalation of oxygen, which occurs under the influence of light. This action of chlorophyll in bringing about the decomposition of carbonic acid is not, as was till recently believed, confined to plants. In the green *Hydra*, and in certain green Planariæ, chlorophyll is differentiated in their protoplasm, and probably always acts here under the influence of light exactly as in plants. Geddes has shown that these animals contain starch-grains in their tissues—another striking point of resemblance between them and plants. A further approximation between the two organic kingdoms has been shown by the researches of Mr. Darwin and others on carnivorous plants. Naegeli has further proved that the cell of the yeast fungus contains peptin, a substance formerly known solely as a product of the digestion of nitrogenous food of animals.

Nothing shows more strikingly the identity of the protoplasm in plants and animals than the fact that plants may be placed, like animals, under the influence of anæsthetics. Plants while under this influence absorb oxygen and exhale carbonic acid, the true *respiratory* function which is ordinarily masked by the predominant function of *assimilation*, which devolves on the green cells of plants, and which manifests itself under the influence of light in the absorption of carbonic acid and the exhalation of oxygen. Hence the respiration of living beings is identical whether manifested in the plant or the animal, and the

supposed antagonism in its respective character is totally demolished.

Enough has been said to show that in protoplasm we find the only form of matter in which life can manifest itself. We are thus led, said Prof. ALLMAN, to the conception of an essential unity in Organic Nature,—a structural unity in as far as every living being has protoplasm as the essential matter of every living element of its structure, and a physiological unity in the universal attribute of irritability, which has its seat in this same protoplasm, and is the prime mover of every phenomenon of life. Mere form has little to do with the essential properties of protoplasm. To suppose that all protoplasm is identical where no difference can be detected by the means at our disposal would be an error. Of two particles of protoplasm between which we can detect no difference, one can develop only to a jelly-fish, the other only to a man; and one conclusion alone is possible—that deep within them there must be a fundamental difference which thus determines their destiny. Of this we know nothing, and can assert nothing beyond the statement that it must depend on their hidden constitution. In the molecular condition of protoplasm there is probably as much complexity as in the disposition of organs in the most highly differentiated organisms. Herein lies the many-sidedness of protoplasm, and its significance as the basis of all morphological expression, as the agent of all physiological work. From the facts which have been here briefly noticed there is but one legitimate conclusion—that life is a property of protoplasm. The essential phenomena of living beings are not so widely separated from the phenomena of lifeless matter as to render it impossible to recognise an analogy between them. Even irritability, the one grand character of living beings, is not more difficult to be conceived of as a property of matter than the physical phenomena of radial energy. It is quite true that between lifeless and living matter there is a difference greater far than any which can be found between the most diverse manifestations of lifeless matter. No one has ever yet built up one particle of living matter out of lifeless elements. Every living creature has its origin in pre-existent living matter; the protoplasm of to-day is but the continuation of the protoplasm of past ages. When we say that life is a property of protoplasm we assert as much as we are justified in doing. We stand upon the boundary between life in its proper conception, as a group of phenomena having irritability as their common bond, and that other group of phenomena which we call consciousness or thought, and which, however closely linked with those of life, are yet essentially distinct from them. When a thought passes through the mind it is associated, as we have reason for believing, with some change in the protoplasm of the cerebral cells. Are we therefore justified in regarding thought as a property of the protoplasm of these cells, in the sense in which we regard mus-

cular contraction as a property of the protoplasm of the muscle? or is it really a property residing in something far different, but which may yet need for its manifestation the activity of cerebral protoplasm?

If, said the PRESIDENT, we could see any analogy between thought and any one of the admitted phenomena of matter, we should be bound to accept the first of these conclusions as the simplest, and as affording a hypothesis most in accordance with the comprehensiveness of natural laws. But between thought and the phenomena of matter there is not only no analogy, but there is no conceivable analogy, and the path we have hitherto followed comes to an end. The chasm between unconscious life and thought is impassable; for even from irritability, to which on a superficial view consciousness may seem related, it is as absolutely distinct as it is from the ordinary phenomena of matter. It has been argued that because physiological activity must be a property of every living cell, psychical activity must be equally so; the language of the metaphysician has been carried into biology, and the "cell-soul" spoken of as a conception inseparable from life. How far back in the scale of life consciousness may exist, we have no means of determining. But even admitting that every living cell were a conscious, thinking being, are we therefore justified in asserting that its consciousness, like its irritability, is a property of the matter of which it is composed? The sole argument on which this view rests is that from analogy, and as there is an absence of all analogy between the things compared it must fall to the ground.

Prof. Huxley, in his lecture on the "Physical Basis of Life," contended that no difference, however great, between the phenomena of living matter and those of the lifeless elements of which such matter is composed, should militate against our ascribing to protoplasm the phenomena of life as properties essentially inherent in it; since we know that the result of a combination of physical elements may exhibit physical properties totally different from those of such elements, the physical phenomena presented by water having, *e.g.*, no resemblance to those of oxygen and hydrogen, As regards the phenomena of life in the stricter sense of the word, the argument is conclusive. But if it be pushed further and extended to consciousness it loses all its force.

That consciousness is never manifested except in the presence of cerebral matter or of something like it, there cannot be a question; but this is a very different thing from its being a property of such matter in the sense in which polarity is a property of the magnet, or irritability of protoplasm. The generation of the rays which lie invisible beyond the violet in the spectrum of the sun cannot be regarded as a property of the medium which by changing their refrangibility can alone render them apparent.

I know that there is a special charm in those broad generalisa-

tions which would refer many very different phenomena to a common source. But in this very charm there is undoubtedly a danger, and we must be all the more careful lest it should exert an influence in arresting the progress of truth, just as at an earlier period traditional beliefs exerted an authority from which the mind but slowly and with difficulty succeeded in emancipating itself.

But have we, it may be asked, made in all this one step forward towards an explanation of the phenomena of consciousness or the discovery of its source? Assuredly not. The power of conceiving of a substance different from that of matter is still beyond the limits of human intelligence, and the physical or objective conditions which are the concomitants of thought are the only ones of which it is possible to know anything, and the only ones whose study is of value.

We are not, however, on that account forced to the conclusion that there is nothing in the universe but matter and force. The simplest physical law is absolutely inconceivable by the highest of the brutes, and no one would be justified in assuming that man had already attained the limit of his powers. Whatever may be that mysterious bond which connects organisation with psychical endowments, the one grand fact—a fact of inestimable importance—stands out clear and freed from all obscurity and doubt, that from the first dawn of intelligence there is with every advance in organisation a corresponding advance in mind. Mind as well as body is thus travelling onwards through higher and still higher phases; the great law of Evolution is shaping the destiny of our race; and though we may at most but indicate some weak point in the generalisation which would refer consciousness as well as life to a common material source, who can say that in the far-off future there may not yet be evolved other and higher faculties from which light may stream in upon the darkness, and reveal to man the great mystery of Thought?

The first Evening Discourse was by Mr. Crookes, F.R.S., "On Radiant Matter:" the second by Prof. Ray Lankester, F.R.S., "On Degeneration;" while the Saturday evening Lecture to Working Men was delivered by Mr. W. E. Ayrton, the subject being "The Transmission of Power by Electricity."

Mr. Crookes's discourse was illustrated by experiments on the movements of molecules in high vacua, some of which were recently described in the "Monthly Journal of Science." According to the best authorities, a bulb 13·5 centimetres in diameter contains more than 1,000000,000000,000000,000000 (a quadrillion) molecules. Mr. Crookes showed that when exhausted to a millionth of an atmosphere there are still a

trillion molecules left in the bulb. To suggest some idea of this vast number he perforated an exhausted bulb by a spark from the induction coil. The spark produced a hole of microscopical fineness, yet sufficient to allow molecules to penetrate and to destroy the vacuum. The inrush of air impinged against the vanes and set them rotating after the manner of a windmill. "Let us suppose," said Mr. Crookes, "the molecules to be of such a size that at every second of time a hundred millions could enter. How long, think you, would it take for this small vessel to get full of air? An hour? A day? A year? A century? Nay, almost an eternity! A time so enormous that imagination itself cannot grasp the reality. Supposing this exhausted glass bulb, indued with indestructibility, had been pierced at the birth of the solar system; supposing it to have been present when the earth was without form and void; supposing it to have borne witness to all the stupendous changes evolved during the full cycles of geologic time, to have seen the first living creature appear, and the last man disappear; supposing it to survive until the fulfilment of the mathematicians' prediction that the Sun, the source of energy, four million centuries from its formation will ultimately become a burnt-out cinder; supposing all this,—at the rate of filling I have just described, 100 million molecules a second,—this little bulb even then would scarcely have admitted its full quadrillion of molecules.* But what will you say if I tell you that all these molecules, this quadrillion of molecules, will enter through the microscopic hole before you leave this room? The hole being unaltered in size, the number of molecules undiminished, this apparent paradox can only be explained by again supposing the size of the molecules to be diminished almost infinitely—so that instead of entering at the rate of 100 millions every second, they troop in at a rate of something like 300 trillions a second. I have done the sum, but figures when they mount so high cease to have

* Mr. Johnstone Stoney has shown (Phil. Mag., vol. xxxvi., p. 141) that 1 c.c. of air contains about 1000.000000,000000,000000 molecules. Therefore a bulb 13·5 centims. diameter contains $13{\cdot}5^3 \times 0{\cdot}5236 \times 1000{,}000000{,}000000{,}000000$ or 1,288252,350000,000000,000000 molecules of air at the ordinary pressure. Therefore the bulb when exhausted to the millionth of an atmosphere contains 1,288252,350000,000000 molecules, leaving 1,288251,061747,650000,000000 molecules to enter through the perforation. At the rate of 100,000000 molecules a second, the time required for them all to enter will be

12882,510617,476500 seconds, or
214,708510,291275 minutes, or
3,578475,171521 hours, or
149103,132147 days, or
408,501731 years.

any meaning, and such calculations are as futile as trying to count the drops in the ocean." Mr. Crookes concluded his lecture by remarking that at length we seemed to have within our grasp and obedient to our control the little indivisible particles which with good warrant are supposed to constitute the physical basis of the universe. We had seen that in some of its properties Radiant Matter was as material as the table, whilst in other properties it almost assumed the character of Radiant Energy. We had actually touched the border land where Matter and Force seem to merge into one another, the shadowy realm between Known and Unknown which for him had always had peculiar temptations. He ventured to think that the greatest scientific problems of the future would find their solution in this Border Land, and even beyond; here, it seemed to him, lay Ultimate Realities, subtle, far-reaching, wonderful.

The Mathematical and Physical Section was presided over by Mr. G. JOHNSTONE STONEY, M.A., F.R.S.

In his presidential address Mr. STONEY sought to show that in the study of mechanics and chemistry the two great methods of investigation, viz., the deductive and the experimental, could best be acquired, and that for a sound grasp of the remaining physical sciences, and especially with a view to further advance in physical science, a command of both methods of investigation is essential. He said that, in order to understand the present position of Natural Science upon the earth, we must remember that the universe is in itself one great whole, which includes minds no less than bodies, for thought is as much a phenomenon of what really exists as motion. But though the universe be but one, man with his limited powers is unable to treat it as such, but has to push his investigation of Nature when and where he can. Thus have arisen many sciences which were at first quite isolated. Their separate condition is a mark of the feebleness of our powers of investigation. Their gradual convergence, and especially where any complete contact can be established between them, is the mark that our advancing knowledge is penetrating deeper.

In the present passing condition of our knowledge then there is one group of sciences which investigate the phenomena of consciousness; another distinct group of the biological sciences; and a third, the group of the physical sciences. These are all but parts of the one great investigation of Nature, but for the present they exist almost disconnected, as separate provinces of human inquiry.

When we endeavour to investigate mental phenomena, we are

encountered by the complexity and remoteness of the effects which present themselves for examination, and by a deep and unpenetrated obscurity hanging over the interval between them and their causes. In order to make any progress even in the subordinate task of tracing out the relations of these effects to one another, the inquirer finds it necessary to venture upon hypothesis, and in all metaphysical speculation we sadly miss that healthy discipline with which Nature in other branches of science relentlessly refutes our hypotheses if they are wrong. Here, then, is a region in which the plausible may be mistaken for the true; and it is unfortunately certain that it has sometimes been so mistaken by the ablest human minds.

The biological sciences treat of all the phenomena of living beings except their mental phenomena, which are those which lie most remote from their causes. Here the complication is less, but it is still too great for the human mind to have yet penetrated behind it. We are still occupied with phenomena which lie at a great distance from their real causes. We are accordingly still far beyond the range of the exact sciences. Most of the great discoveries of biological science have been made by estimating the *general drift* of what is taught by a vast number of particular facts. This, it will be observed, is a kind of reasoning that is necessarily more or less inexact, and, as a consequence, it is one which requires wide intellectual training and great experience and tact to handle it with safety. When the investigator has brought these qualifications to his task, astonishing progress has been made in these sciences: without them the reasoning may degrade into being either trivial or loose.

In the rest of the study of Nature we are not embarrassed by the phenomena of life, and many mysteries therefore stand aside out of our path. Here lies the domain of the physical sciences. It is here that the mind of man has best been able to cope with the realities of the universe, and in which its greatest achievements have been effected. It is here that exact reasoning finds a predominant place.

In meteorology, owing to the complication of the materials that have to be dealt with, we must have frequent recourse to the same kind of reasoning as has been found so effectual in the biological sciences; but in the other physical sciences exact reasoning prevails, and on this account they are frequently classed together as the exact sciences.

The process of investigation in the exact sciences is fundamentally one in all cases. It has been well described by Mill in the third book of his "Logic." Nevertheless, it is notorious that minds which are well fitted for some branches of physical inquiry find difficulty—sometimes insuperable difficulty—in pursuing others. It is not every eminent mathematician who would have made an equally good chemist, or *vice versa*. This

is because there exists a practical distinction separating the investigation of exact science into two well-marked classes when they are viewed, not as they are in themselves, but in their relation to the powers of us human beings. All valid investigations in exact science appeal to what can be directly perceived, and all lead to a conclusion which can be reasoned out from it; but there are some of these investigations in which the main difficulty consists in making the appeal to the senses, and there are others in which the main difficulty lies in the process of reasoning.

To contend with these difficulties successfully requires very different qualities of mind and body. In experimental science the powers principally called into requisition are readiness and closeness of observation, dexterity in manipulation, skill in devising expedients, accuracy in making adjustments, and great patience. It also requires that the investigator should have an accurate memory of what else he has witnessed resembling the phenomenon under observation, that he should be quick to detect every point of agreement and difference that can be perceived, and be skilful to select those which are significant, and to employ them as materials for provision to guide his further proceedings. But the strain on the reasoning powers is generally less, often of trifling amount. The question is put to Nature, and it is Nature usually that gives the bulk of the answer. The most striking monument of splendid achievements by the experimental method of investigation unaided by the deductive method is to be found in the science of chemistry.

An equally typical instance of the power of the deductive method is the science of mechanics. This science, which has sunk deeper into the secrets of Nature than any other science, and which is the science towards whom all other physical sciences are at present more or less gravitating, is essentially deductive. There is little or no difficulty about its fundamental data. They are facts of Nature so patent to all men, and so indelibly implanted in human conception, that some persons have supposed that we have an intuitive perception of them. But, while the materials from which the mind is to work are thus easily obtained, it has taxed to the utmost the reasoning powers of understandings like Newton's to evolve the few consequences of them which are already known, and the investigator has to call to his assistance every aid to prolonged consecutive thought which mathematicians can devise.

No reach of intellect applied to the materials in existence before 1860 could have elicited the fact that iron exists upon the sun. This great discovery was made by Professor Kirchhoff, a scientific man who was equally versed in both methods of investigation. It was the experimental method he employed. Kirchhoff's great merit and the real difficulty of his work lay in

the scientific foresight and the industry which were required to frame hypotheses that were worth testing, to guide the investigation by these hypotheses, to contrive, construct, and adjust adequate apparatus, and to make with it the elaborate observations and the exact observations and maps which were necessary. But when by these means the new facts had been brought to light, the inference from them that there is iron in the atmosphere of the sun was an easy one. This example will better convey than a definition what are the characteristic features of an experimental inquiry.

On the other hand, no series of observations or experiments, however skilfully arranged, could have enabled anyone to understand the cause of that familar but truly surprising phenomenon that a top stands upon its peg while it is spinning. But a full explanation of it is within the reach of any student who will train his mind to reason consecutively, and avail himself of the aids to prolonged consecutive thought which mathematicians have contrived. He will then see that the most obvious and familiar mechanical facts involve as necessary consequences all the phenomena which he finds in the schoolboy's top, in the physicist's gyroscope, and in the precision and nutation of the heavens. This, then, is a problem of Nature which falls within the province of the deductive method.

Whatever data are known exactly, these inferences from these data, however remote, may be depended upon as corresponding with what actually occurs in Nature. And if in such cases the mind of man has proved equal to the task of drawing inferences which can effectually grapple with the problems he finds around him in the Universe—which is, alas! as yet but too seldom—then will the deductive method, our plummet, explore depths in the great ocean of existence which our anchors of experiment could not have reached.

We must bear in mind that either method of investigation may be misapplied, and that this is a risk carefully to be guarded against. The deductive method when misapplied lands us in speculation; the experimental method becomes empiricism; and it so happens that the sciences of mechanics and chemistry are not only monuments of the power of the two great methods of investigation, but instructive examples of their weakness also. For in chemistry scarce any attempt at prolonged reasoning, carrying us by any lengthened flight to a distance from the experiments, can be relied on. The result has seldom risen to anything better than speculation. And, on the other hand, in mechanics, conclusions which depend on experiments only are empirical; that is, they are deficient in accuracy, and their relation to the other phenomena of the science is left in darkness. Here, then, we find in these two sciences not only how strong these two methods of investigation are, but how weak they may become if misapplied.

In the study of mechanics, however, and in the practice of chemistry, the two great methods of investigation may be studied separately, by steps of graduated difficulty, and with a superabundance of materials; and each of them supplies the necessary cautions with respect to the method which is all powerful in the other. No scientific man is really equipped for the pursuits in which both methods have to be employed till he has separately acquired a grasp of each. For it is only then that he will be armed against the errors which lead so many to mistake empirimism on the one hand, and speculation on the other, for solid science, or to underrate solid science, mistaking it for speculation. Nor is it only in his scientific occupations that he will derive benefit from this training. All exact reasoning, whether in science or in common life, belongs to these great divisions; and in the numberless instances in which we must be satisfied with reasoning which falls short of being exact, our only safety lies in having by the practice of exact reasoning, both deductive and experimental, attained to that intellectual tact and caution which alone will enable us to handle with safety the sharp and slippery tool. It is thus that a sound judgment with regard to truth may best be acquired by man or woman; and soundness of judgment is the noblest endowment of man's understanding, just as veracity is first among his virtues.

We shall conclude our report of the Proceedings of the Association in our next issue.

NOTICES OF BOOKS.

Fragments of Science: A series of detailed Essays, Addresses, and Reviews. By JOHN TYNDALL, F.R.S. Sixth edition. London: Longmans and Co. 1879.

THIS valuable collection of scientific essays now appears in the form of two substantial volumes, containing articles contributed to various magazines, Royal Institution lectures, and the celebrated Belfast Address. The range of subject-matter is very large: physics proper, chemistry, geology, philosophy, and even theology, are discussed in one or other of the articles. While the first volume deals specially with the phenomena of matter; the second treats of the correlation of phenomena of mind and matter. In the preface to this edition the author says: "In neither volume have I aspired to sit in the seat of the scornful, but rather to treat the questions touched upon with a tolerance, if not a reverence, befitting their difficulty and weight."

In the first volume, the author introduces various contributions to molecular physics; experiments on para-magnetic and diamagnetic forces; on dust and disease; and on fog signals. The memoirs of Faraday, Mayer, and Joule also appear; and the first article discusses spiritualism. In the second volume we find the well-known articles on scientific materialism, on the efficacy of prayer, and on the scientific use of the imagination. The Belfast Address, the apology for it, and the reply to the Rev. James Martineau's essay on the subject, are also here given. Then follow various lectures on fermentation, the germ-theory, and spontaneous generation, and the book is concluded by the lecture on the electric light delivered at the Royal Institution in January last. We feel sure that although the essays on materialism and prayer will offend the sensibilities of many readers, these fragments of science will continue to receive a large share of public attention.

Researches on the Motion of the Moon, made at the United States Naval Observatory, Washington. By SIMON NEWCOMB, Prof. U.S. Navy. Part I. Washington. 1878.

THIS first part of what will be a very lengthy and valuable monograph relates to the reduction and discussion of observa-

tions of the moon before 1750. An historical introduction is followed by an account of various ancient eclipses of the sun and moon, beginning with the eclipse of Thales, passing on to the Ptolemaic eclipses of the moon recorded in the Almagest, and the Arabian observations, as given in the writings of Ebu Gounis. These are followed by the observations of Bullialdus, Gassendus, and Hevelius, and the astronomers of the French School before 1750. A technical mathematical discussion of the moon's mean motion and of the value of the secular acceleration concludes this portion of a work which will be welcomed by astronomers in every part of the world.

A Treatise in Popular Language on the Solar Illumination of the Solar System. By COLLYNS SIMON. Williams and Norgate. 1879.

THE contents of this work is so very fully set forth in the title page, and we can have so little to say to such a treatise, that we confine our notice to a transcript of the title page:—"The solar illumination of the solar system, or the law and theory of the inverse squares; being an analysis of the two received laws relating to the diminution of light by distance, wherein it is shown that, according to undisputed facts of nature and of science, the solar illumination is equal throughout the whole system, and the law of inverse squares for light, physically impossible. To which is added the prospectus for a prize of fifty guineas offered for disproof of the scientific facts here for the first time indicated."

In the same category we must place Mr. Orson Pratt's "Key to the Universe, or a new theory of its mechanism founded upon a continuous orbital propulsion, arising from the velocity of gravity and its consequent aberrations, and the resisting ethereal medium of variable density."

Dreams of my Solitude on the Mysteries of the Heavens. By JOSHUA PRUSOL. London: Reeves and Turner. 1879.

THIS work, of a severely essaic type, may commend itself to certain dreamers who are not *au courant* with the courses and ways of modern science. Although highly imaginative, it is not devoid of profound thought, and we cannot too highly praise the singular modesty of the preface; specially of the concluding sentence, in which the author says, "Dear, naturally, as these

speculations are to him, the truth is dearer, and according as they consort or do not consort with it, does he expect others to give them entertainment, or undertake to denounce and repudiate them himself."

Navigation and Nautical Astronomy, with Special Table, Diagram, and Rules adapted for Navigating Iron Ships. By the Rev. W. T. READ, M.A. London: Elliot Stock. 1879.

AN useful work containing many original examples, and well adapted for teaching young naval officers the first principles of navigation.

The Electric Light in its Practical Applications. By PAGET HIGGS, LL.D., D.Sc. London: E. & F. N. Spon. 1879.

THIS work is specially devoted to a description of the various attempts which have been made to obtain a practicable system of electric lighting. An introductory chapter on the general principles of the voltaic arc and the method of lighting by incandescence is followed by chapters on electric lamps and candles; magneto and dynamic machines and their efficiency, and electric regulators; the division of the electric light is briefly discussed, and finally the commercial aspect of the question, and the various applications to military, maritime, mining, and other purposes.

In the first chapter the avoidance of waste of light is much insisted on, and the author asserts that when the laboratory of the Sorbonne was first lighted by electric candles "at least one-half of the light produced" was lost by radiation towards the sky through the glass roof of the building which served to light it during the day. The loss by this means in the case of an open-air light exposed at a considerable elevation, and unfurnished with reflectors, must be enormous. In the second chapter the various voltaic-arc lamps are described and figured; the last-mentioned of these—Higgs's lamp—is said to produce, with only four ordinary Bunsen elements, sufficient light to illuminate a building 60 feet by 40, and, when worked by a dynamo-electric machine of 2½ horse power, to produce four lights each equal to 400 candles. It simultaneously utilises the principles of incandescence, of the arc, and of the extra spark. Among the candles and candle lamps of course Jablochkoff's candle is the most prominent. It was invented in 1876, and has the special advantage that it entirely dispenses with any

kind of mechanism. In fact, the candle simply consists of two cylindrical rods of carbon, about three-sixteenths of an inch in diameter, and from 6½ to 10 inches in length; they are placed vertically side by side, with a space of three-sixteenths of an inch between them, which is filled with plaster-of-Paris. The latter is fused as the arc passes at the extremity of the candle, and this fusion absorbs 30 per cent of the electric current; moreover, the candle, if once extinguished, cannot be re-lighted. With a light equal to 760 candles, three inches of carbon are consumed per hour. Wilde has modified Jablochkoff's candle, by removing the insulating plaster-of-Paris. The lamps for lighting by incandescence alone have not at present made much way.

In the fifth chapter the general principles of magneto and dynamo-electric machines are fully discussed. Commencing with the machines of Pixii and Clarke, and ending with those of Gramme, Edison, and Lontin-Siemens machine is effective, but it can only be used with one Serrin's or Siemens's lamp. It is said to give the following results:—

Revolutions per minute.	Illuminating power. Standard candles.	Horse power.	Weight.
850	1,200	2	280
650	6,000	4	420
360	14,000	8	1,288

Useful tables showing the efficiency of different forms of dynamo-electric machines are given on pp. 133, 136, 138, 140, 143, and 149. The highest recorded efficiency of a dynamo-electric machine is 38 per cent., while the efficiency of an ordinary steam engine in utilising the heat of the fuel does not exceed 20 per cent. The power expended by a dynamo-electric machine in producing the light of one sperm candle is about equivalent, according to the author, to 90 lbs. falling through one foot in one minute.

Some very interesting details as to the loss of production of the electric light compared with gas are given in the ninth chapter. The cost in Paris is said to be double that of an equally intense street lighting by gas. One electric light can usually be substituted for ten or twelve gas jets. The power absorbed is equal to one horse-power per candle. The subject of electric carbons is discussed in the last chapter. Archereau mixes carbon with magnesia. Carré with different salts. Those of potash and soda at least double the length of the arc. Gaudoin introduces phosphate of lime and various silicates and borates; others have coated the carbons with a deposit of metal such as nickel or copper, or have incorporated iron or copper in powder with the carbon. Gramme's experiments with carbons saturated with nitrate of bismuth proved that a considerable increase of light resulted.

Mr. Higgs's work gives us a very fair *resumé* of the whole subject of electric lighting, accompanied by an impartial discussion of the subject, and illustrated by excellent and numerous woodcuts. The perusal of the book forcibly impresses upon us the belief that the subject is still quite in its infancy, and that if the advances of the next fifteen years are as great as those of the last fifteen, we may expect to see gas very largely replaced by electricity.

The Student's Text Book of Electricity. By HENRY M. NOAD, F.R.S. A new edition. Edited by W. H. PREECE. London: Crosby Lockwood and Co. 1879.

THIS well-known work has been carefully edited by Mr. Preece, who has supplied new chapters containing a description of the most recent developments in all branches of electricity. The principles of duplex and quadruplex telegraphy, of the various electric lamps and candles, and of the telephone, and microphone have been fully explained, and constitute some of the most valuable portions of a book which will meet the requirements of a large number of students now as heretofore.

Four Lectures on Static Electric Induction. By J. E. H. GORDON, B.A. London: Sampson Low and Co. 1879.

THESE lectures, delivered at the Royal Institution, contain, as the author truly remarks, an account of a few phenomena which we can explain, and of a great many which we cannot. The results, however, have been discussed in a very suggestive and able manner, and the work cannot fail to recommend itself to all students of electricity. The more so when we remember that since the memorable monographs of Faraday comparatively little has been written on static electrical induction.

Mechanics. By R. S. BALL, F.R.S., Royal Astronomer of Ireland. London: Longman and Co. 1879.

THIS volume belongs to the "London Science Class Books" Series, and is carefully written and well illustrated. It will be useful for the higher forms in our public schools. The style is

good, and the subject is not overburdened by mathematical treatment. A fair example of the lucid explanation and admirable illustration of a subject will be found under the head of "friction on the inclined plane" (pp. 92, 93.)

Outlines of Geology and Geological Notes of Ireland. Being an Account of the Formation and Localities of its Mineral Resources. With an Addenda, containing Disintegration of Rock, Antiquity of the Earth, Climatic Changes of the Earth, Supposed Antiquity of Man, and the author's concluding Note. By WILLIAM HUGHES. Third edition. Dublin: M. H. Gill and Son, and W. H. Smith and Son.

WE have here a manual of the mineral resources of Ireland, along with descriptions and illustrations of the wild and sublime scenery of its coasts. Such a work, doubtless, might serve the very important purpose of drawing the attention of its readers to the great truths of geology and leading them on to become observers. So far as the author confines himself to a description of facts we can follow him with approval. But when he enters upon speculation and theory we are compelled to put in our protest. Mr. Hughes is in the first place a catastrophist of a school which we had supposed extinct. He declares that "this earth was subjected to repeated changes, that thousands of years intervened between them, and that each completely destroyed all vegetable and animal life." To him the history of our globe is not a career of regular development, but an alternation of extirpations and creations, separated by "periods of repose." It might have been hoped that notions so irreconcilable with recent discoveries and observations would no longer be reproduced in a popular treatise.

We are unfavourably impressed, too, with the apologetic tone of the work and with its vacillating character. At one moment the author seems to have fully grasped the great truth that "revelation was given not to inculcate physical science," but the next he is reconciling geology with Genesis—a process which his former admission ought to render needless. On the supposed high antiquity of the human race he declares (p. 117) that "we must leave our readers to draw their own conclusions from the evidences we have laid before them;" but, in his concluding note, he withdraws this permission and declares, "To those whose minds are not warped (!) there can be no doubt whatever but that man's appearance upon this terrestrial scene is as we have been all taught to believe it, and as Holy Writ gives it in the simple narrative of the creation." So then, in this respect at least, "revelation has been given to inculcate physical science."

Though holding very positively the belief that the interior of our globe is in a state of igneous fusion, he does not appear to accept the nebular hypothesis, since he repeatedly speaks of the earth being first "launched into space" and likewise suggests that it may have existed for ever.

Descending to matters more closely connected with daily life, we find Mr. Hughes adopting the theory, first broached, we believe, by Prof. Hull, that the seams of coal formerly occurring in Ireland have been transferred to Britain! That the central limestone plain of Ireland was once covered over with carboniferous beds, so that these strata have been gradually denuded by the action of water and other agencies we do not dispute. It seems to us, however, that if a region of coal-seams, intersected and separated from each other by beds of shales, sandstones, &c., were carried, little by little, into the adjoining ocean, and there deposited, we should not find them there rearranged in distinct layers. Coal, shale and grit-stones would be all comminuted and blended together in confusion. Prof. Hull, it must not be forgotten, only gives a questioning adhesion to this wild hypothesis, since he speaks of the Irish strata as forming "perhaps some of the strata which were being piled up over the ocean-bed of the British area." What good cause can be shown that the British coal-seams were not formed from vegetable matter *in situ?*

What shall we say of this passsge: "All his (Voltaire's) ingenuity was employed to oppose the Mosaic account of the creation and the deluge; for instance, he asserts that the shells discovered in Alpine regions are simple freaks of nature, or else they were carried thither by pilgrims from Syria; therefore, so much for the opinions of men of science of the last century." Although we can by no means recognise Voltaire as a true man of science, and though we consider his explanations of fossil shells as utterly groundless, we must remember that the former of them was shared by many orthodox divines, and that neither of them is more outrageous than their ascription to the Noachian deluge, or than the hypothesis advanced by a man of science still living that they are forgeries, divinely perpetrated to lead vain man into error. If Mr. Hughes will search he will find that the eighteenth century is rich in illustrious men of science.

We are by no means disposed to deal severely with inelegancies and inaccuracies of expression so long as they do not obscure an author's meaning. Still, such utterances as "I have added an addenda," "an isolated strata," &c., rather grate upon our feelings. What, too, must the classical scholar think of the subjoined rendering:—"eocene, miocene, pliocene and, post-pliocene, all compounded of Greek words signifying 'earliest new,' 'less new,' 'more new,' and 'often more new.'"

We very much regret that in the interests of science we cannot give this book our recommendation.

Annual Record of Science and Industry for 1878. Edited by SPENCER F. BAIRD, with the assistance of eminent men of Science. New York: Harper Brothers. London: Trübner and Co. 1879.

THE eighth issue of this useful compilation is fully equal to those which have preceded it. The volume is divided into sixteen sections—Astronomy, Physics of the Globe, Physics in General, Chemistry, Mineralogy, Geology, Hydrography, Geography, Microscopy, Anthropology, Zoology, Botany, Agriculture, Engineering, Technology, and Industrial Statistics. The Appendix contains a necrology and the bibliography of the year.

One of the best sections in the book is the first, Astronomy, edited by Prof. E. S. Holden, of the Naval Observatory, Washington. The great solar eclipse of July 29th, 1878, of course occupies the largest amount of space, the American observers naturally getting the lion's share. The transits of Mercury and Venus, also, come in for a large share of attention. Professor Holden gives an interesting *bibliographie raisonnée* of his own particular subject, and it would have been as well if all his colleagues had followed his example instead of relegating the matter to an Appendix. So much trash in a scientific way is published now-a-days that one wants to know briefly, but honestly, what a book is worth, and not merely its name, author, size, and price. An interesting Report on American Observatories is given in this section.

The section edited by M. Clement Abbé and Prof. Rockwood, and devoted to Physics of the Globe, is also well treated, taking up no less than 118 pages, or a fifth of the whole book. The subject is well arranged, being divided into three broad headings —the Earth, the Ocean, and the Atmosphere. The value of the section is however, greatly impaired by the paucity of bibliographical references. Such books as the present are not bought merely as a matter of scientific curiosity, but as works of reference, and neither names, discoveries, nor researches should be mentioned without giving every particular that is necessary for obtaining a perfect knowledge of the matter.

These remarks apply with more or less justice to many of the other sections, especially to that on Physics, by Professor Barker, which is the most deficient of them all in bibliographical references.

The very unequal amount of space given to the different sections is apparent in the meagre account given of the year's chemical research, also by Prof. Barker.

Setting aside the defects we have mentioned, Mr. Baird's work is most valuable.

CORRESPONDENCE.

THE ANOMALOUS SEASON.

To the Editor of the Monthly Journal of Science.

SIR,—The author of the article "The Anomalous Season," inserted in your last issue, might have added, on the authority of Knapp, that the hot summer of 1825 had been preceded by a mild wet winter, and was followed by another summer almost as hot and dry, whilst in the intervening winter (1825-26) snow and frost only lasted about ten days. This certainly confirms the view that exceptional weather, when it sets in, lasts for more than one season, and that a warm summer is generally preceded by a mild winter.—I am, &c.,

AN OBSERVER.

ACTION OF LIGHT UPON THE COLOURATION OF THE ORGANIC WORLD.

To the Editor of the Monthly Journal of Science.

SIR,—I have this year observed a phenomenon which scarcely agrees with certain generalisations upon which I ventured in an article on "The Action of Light upon the Colouration of the Organic World." I there said that "pure and bright colours are connected with the highest vitality only," and further, that the process of decay is "attended by a degradation of colour." This year, however, I have been struck with the fact that the flowers of the common whitethorn, when about to fall and after their odour has disappeared, assume, not like other white flowers a dirty brown, but a pure and delicate pink or rose shade, with minute specks and points of a very decided red. I have carefully examined these colours, and find them free from any approach to a maroon or a liver.colour, which we might more easily associate with decay. It is striking that we should have here a change exactly the reverse of what takes place in the rose, the apple-blossom, and the almond. All these open with

various shades of red or pink, and fade towards a white; yet they belong to the same botanical family as the whitethorn. The change in question, though very general, was by no means universal, and it seemed to me most pronounced in situations little exposed to the direct rays of the sun.—I am, &c.,

J. W. S.

HUMANITARIANISM EXTRAORDINARY.

To the Editor of the Monthly Journal of Science.

Sir,—At a meeting held in connection with the recent Westminster Exhibition, Mr. J. G. Talbot, M.P., is reported to have said, in reference to some cases of butterflies there displayed, that such collections involved a "fearful waste of insect life," and to have expressed a wish that Entomology could be "studied in a more humane manner." It really seems as if, in these virtuous days, the infliction of pain or of death is to be tolerated for any and every purpose, save in the pursuit of knowledge. The number of insects sacrificed for preservation in museums and in private collections, or for microscopic examination, &c., seems to me a mere trifle compared with those destroyed out of mere wantonness or for ostentatious decorations. In the shops of certain "naturalists" (save the mark!) we may see trays and boxes full of splendid Buprestidæ, &c., which are sold to jewellers, milliners, &c. Might not Mr. Talbot have found here a "waste of insect life" much more to be regretted? With birds the case is even more glaring. I will venture to say that for one which falls a sacrifice to Science, ten become victims to Sport and to Fashion. But the modern humanitarian dares not attack Sport and Fashion, so he seeks to fetter Science. Biologists greatly deceive themselves if they think that even the total abolition of vivisection will satisfy the "hysterical party." It is surely time for the organisation of a "Biological Defence League."—I am, &c.,

Awake!

HABITS OF SERPENTS.

To the Editor of the Monthly Journal of Science.

Sir,—Waterton strongly insists, in his Essays, that serpents never pursue a retreating prey, and never act gratuitously upon the offensive. Both these statements are contradicted by more

recent observers. The late Mr. Belt describes a serpent chasing a lizard among the branches of a tree, and Dr. Livingstone gives an instance of an African serpent emerging from its hole, biting with fatal effect a man who was passing, and then returning to its hiding-place. Is anyone among your readers able to state whether wild animals, too large to become the prey of poisonous snakes, are ever bitten and destroyed by them? Has anyone ever found in the woods of India, of the Malayan Islands, or of Africa, any dead carnivore, ape, antelope, &c., whose death could be plainly traced to serpent-bite? That domestic animals thus perish, especially dogs, is a well-known fact.—I am, &c.,

VERIFIER.

XUM